CENTRAL BASIN AND RANGE
RAPID ECOREGIONAL ASSESSMENT
FINAL WORK PLAN I-4-C

REAWP for:
Department of the Interior
Bureau of Land Management
Rapid Ecoregional Assessments

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This work plan will be updated until approved by BLM in Phase I Task 4. Thereafter revisions will be documented on the "Approved Changes" page.

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Figures

Approved Changes

Change	Submission date	Approval date
Draft	April 5, 2011	
Final	May 19, 2011	

Central Basin and Range Rapid Ecoregional Assessment Work Plan

Introduction

Task 4 of Phase I of the Central Basin and Range (CBR) Rapid Ecoregional Assessment (REA) calls for development, submission, review, and approval of a work plan to conduct Phase II work.

This workplan is organized by task (phase II Tasks 1-3 now referred to as Tasks 5-7; see Table 1) and we reference steps of the workflow as applicable (many steps are internal to BLM review). After approval, any significant changes (identified in consultation with BLM POC) will be submitted in writing for BLM approval and recorded in the Approved Changes summary in this document.

The key parts of this REAWP are:

1. Process work flow diagrams (for Phase II and for tasks) that incorporate the flow of data and the activities of contractors, BLM staff, and the AMT.
2. Information work flow diagrams (for Phase II and for tasks as needed) that focus on the flow of information from sources through analyses to products.
3. Summary schedule
4. A Data Management Plan
5. Phase II tasks work descriptions using the following template:
   Applicable scenario(s): if applicable to the task item, this identifies which of the 3 scenarios this item applies to.
   Inputs required: summarizes the data inputs
   Analytical process: summarizes the modeling/analytical process
   Outputs: specifies the types of map and quantitative outputs
   Anticipated timeline: months that the activity will take place
   Issues & limitations: summarizes key issues and limitations known for the activity.
6. Appendices
   a. Appendix I contains the MQ table that clarifies the established (as of acceptance of the workplan) MQ definition, data inputs, models to be applied, reporting unit, and reporting metrics. We have also included a comments field to clarify the MQ definition and or to indicate remaining issues to be resolved about the MQ.
   b. Appendix II lists coarse-filter Conservation Elements for modeling. Landscape species CEs and species assemblage CEs that were previously listed in an appendix have been moved to appropriate tables within the main workplan.

Table 1. BLM REA Phases and Tasks

Phase #	Phase	Task #	Revised Task #	Task Description
Phase I	Pre-Assessment	Task 1	Task 1	Refine Management Questions, Select Conservation Elements
Phase I	Pre-Assessment	Task 2	Task 2	Identify, Evaluate, and Recommend Potential Data
Phase I	Pre-Assessment	Task 3	Task 3	Identify, Evaluate, and Recommend Models, Methods, and Tools
Phase I	Pre-Assessment	Task 4	Task 4	Prepare Rapid Ecoregional Assessment Work Plan (REAWP)
Phase II	Conduct Assessment	Task 1	Task 5	Compile and Generate Source Datasets
Phase II	Conduct Assessment	Task 2	Task 6	Conduct Analyses and Generate Findings
Phase II	Conduct Assessment	Task 3	Task 7	Prepare Rapid Ecoregional Assessment Report and Documents

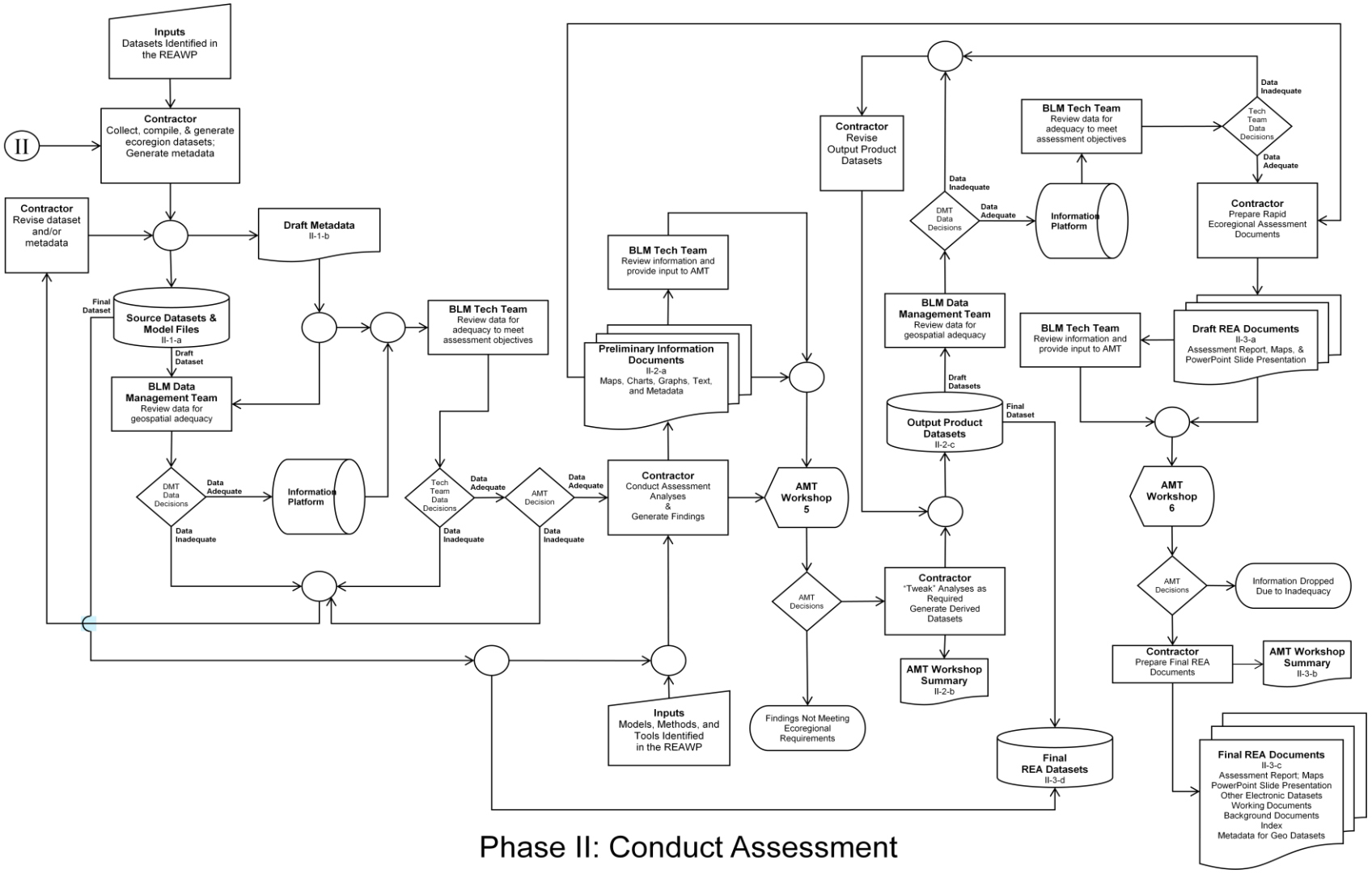
Workflow

Figure 1 depicts the general information workflow for Phase II that leads from source data inputs, through data generation for CEs and CAs (as needed) to a hierarchy of MQ assessments. Figure 2, provided by BLM, diagrams the process workflow for information, contractor work, BLM work, and AMT interactions. For each Phase II task detail section we provide an expansion of the relevant portions of the diagram. For these diagrams we added objects to provide more detail with bold outlines for clarity.

Figure 1. Generalized information workflow for Phase II.

Development of Ecological Integrity Assessment (EIA) Scorecard indicators and metrics occurs in Task 5. The application of EIA to assess current condition of each CE occurs in Task 6.

Figure 2. Process workflow for Phase II.



The original numbering of the Phase II tasks is followed in this diagram. II-1 = Task 5; II-2 = Task 6; II-3 = Task 7.

Summary Phase II Schedule

Note that the dates are provided as the start of the week of anticipated completion / delivery / occurrence of the activity except where noted with an * to indicate a specific date. This is to allow flexibility in scheduling, particularly for AMT meetings. Note proposed changes to activities and dates in Task 7. Note that actual work on a select group of approved activities for Task 5 was initiated in late March 2011 per agreement with BLM.

Table 2. Summary schedule

Date	Activity
	Phase I Task 4 Workplan
04/08/11	Submit workplan (I-4-a)
04/18/11	AMT workshop 4 webinar to review REAWP
05/20/11*	Final workplan submission (I-4-c)
	Phase II Task 5 Data Generation
06/30/11*	Delivery of generated datasets (II-1-a) and metadata (II-1-b). Note that it is anticipated that data will be delivered as it is completed rather than as one consolidated delivery per BLM request.
06/27-07/22	Specialized data and methods webinars (CBR and MRB will be held together)
07/05/11	BLM data review/approval
	Phase II Task 6 Assessment
09/03/11	Preliminary information documents (II-2-a)
09/13/11	BLM Review of II-2-a
09/15/11	AMT Workshop 5 (proposed 2-day workshop)
10/23/11	Revised documents (II-2-c)
10/28/11	BLM Approval Review
	Phase II Task 7 Final documents delivery
11/23/11*	Draft Ecoregional Assessment Report (II-3-a) (proposed revised date)
12/05/11	AMT Workshop 6 (proposed webinar and proposed revised date)
1/06/12	Contractor plan to revise deliverables per comments (proposed new task)
1/31/12	Project completion - Final documents (II-3-c) & datasets (II-3-d)
2/10/12	BLM Approval Review

Data Management Plan

The REA process will utilize and generate many datasets, both tabular and spatial, along with many documents. NatureServe has implemented tools for tracking both data and documents which integrate and follow BLM guidelines for such. Below we provide information about several aspects of our data and document management, but focus primarily on data management & documentation. Some aspects of the data management remain to be resolved through interaction with the BLM NOC data team as they work through the implementation of the BLM REA data portal, and other contractor requirements.

Secure File Transfer

NatureServe established a secure file transfer site for the BLM REA work that is being used for transferring data between NatureServe, NatureServe sub-contractors, and data sources. The secure file upload requires a username and password, and files placed in this repository can only be retrieved by NatureServe data management staff. This upload resource is being used to allow people to contribute data in a secure manner. For datasets that NatureServe need to share with REA subcontractors, NatureServe has established a secure file download site that requires a different username and password. All usernames and passwords are tightly controlled and only distributed to the relevant project team members.

BLM has indicated that in the coming months, its official data portal will be set up and ready for use. We will continue to use the process described above until BLM has indicated that the portal will be ready. We will coordinate with BLM to ensure a smooth transition to the use of the portal.

SharePoint Site – Data Management

Based on the materials developed for Phase I Task 1, NatureServe identified the desired data to evaluate for possible inclusion in the assessment to represent Conservation Elements (CEs), Change Agents (CAs), and Places (PLs). Working closely with BLM to minimize redundancy in data requests, the responsibility for identifying datasets was assigned to various team members based on areas of expertise. When possible, we obtained the full dataset plus all supporting metadata and reports. When the data were not available, we requested and obtained at a minimum metadata and supporting materials, with sample data as available. As each member of the team worked through their list of datasets, the information was entered in the Master Data List (described below) and the appropriate team experts notified so they could begin the data quality evaluation process.

Using Microsoft SharePoint software, NatureServe has created a secure collaborative workspace for the REA project team. The Data Management component of this SharePoint site includes resources such as technical instructions and documentation, including data management guideline materials provided by BLM, and a "Master Data List" that is NatureServe's core tool to track work status, conduct data evaluations, and prepare materials for reporting and creating tables.

To create the Master Data List, NatureServe initially imported to SharePoint the spreadsheet provided by BLM: "Att6.2-DMP-DataLayers.xlsx." After reviewing the materials in the document "Rapid Ecoregional Assessment (REA) Data Management Plan: Contractor Guidance," NatureServe added attributes from the following appendices (from BLM's data management guidelines) critical for achieving compliance with those guidelines:

Appendix 7: Data Quality Evaluation Worksheet
Appendix 8: QA/QC Checklist
Appendix 9: Pre-Acquisition Data Assessment Worksheet

In addition, the NatureServe project team added attributes to the Master Data List for internal data management and tracking purposes.

The information already captured in the Master Data List provides the foundation for the Phase II Task 1 compilation and generation of source datasets. We are tracking which datasets have been requested, acquired, and their physical management. This will be expanded to include generated datasets, as well as the scripts and modeling processes used. We will build on the existing "metadata" attributes to track the creation and review of metadata for generated datasets, and will apply the existing Data Quality Evaluation to these generated datasets.

Data Management and Tracking

The Master Data List is NatureServe's primary tool for managing information about the individual datasets as well as tracking status of the work being conducted. These include:

- information about source and generated datasets(filename, data source, citation, description, data type, scale, ISO category, currentness, data agreements, data restrictions / sensitivity, metadata)
- information about data management (filename and location where data resides on NatureServe's servers)
- work status (person requesting the data; data acquisition status and date; who needs to assess the dataset; and review status)
- how data will be used in the REA analyses (type of CE, CA, or place; applicable REA(s))
- additional information about generated datasets / REA deliverables that will be used to complete the Data Delivery Tracking Form (DDTF) (type of deliverable, description, delivery date, software used, model or script used, layer filename, point of contact)
- status of metadata for generated datasets (created, reviewed, reviewers, finalized)
- additional information about map products that will be used to complete the Map Delivery Tracking Form (MDTF) (map name, map description, figure number (if known), and datasets that the MXD contains).

Data Evaluation

The Master Data List has been NatureServe's primary tool for conducting the Phase I, Task 2 Data Quality Evaluation. To conduct this data evaluation, NatureServe started with the materials in "Appendix 7: Data Quality Evaluation Worksheet" and enhanced these by including a *Comments* field for each of the eleven Data Quality Evaluation criteria. This *Comments* field allows the expert conducting the data review to explain the assignment of one of the following confidence ratings: Very High, High, Moderate, Low, and Unknown. NatureServe's evaluation also includes information on the intended use of the data, and the suitability for these uses. Based on the information in the data evaluation attributes, NatureServe then assigns an Overall Data Confidence Rating, again accompanied with comments where relevant.

The data evaluation process employed by NatureServe also encompasses metadata. The Metadata review includes an evaluation of whether the metadata are incomplete (missing key information), minimally complete (has abstract, purpose, currentness, scale, projection, attribute definitions, and contacts), or accepted (the data have robust, complete metadata). And the reviewer can enter comments about the metadata, particularly if there are incomplete areas or questions that need to be resolved.

NatureServe has found that data quality varies considerably. Despite that, we have resisted assigning a fixed threshold that dictates what data will and will not be used in the REA. Data evaluation has focused more on the concept of "fitness for intended use" which is consistent with the BLM data quality protocols.

Document Management and Tracking

Developed in parallel with the Master Data List, NatureServe has created on its BLM REA SharePoint site a Document Management List that is the primary tool for managing both reference materials cited in BLM REA memoranda and the documents generated as part of the project (memos, summaries, presentations, meeting notes, etc.). In Task 7, the data in the Document Management List will be exported to an Access database table as a deliverable, which will provide a complete cross-referencing of all documents to the REA Phases, Tasks, other deliverables, and CEs, CAs, or Places. The Document Management List includes:

- Information about the document (title, citation, publication date, type of document, keywords, restrictions / sensitivity)
- Copy of the document attached to the SharePoint record (where possible)
- Information about the document location, if not attached to the SharePoint record (URL or physical location)
- Document acquisition status (person who provided or acquired the document; acquisition status)
- How the document is being used in the REA analyses (type of CE, CA, or place; applicable REA(s); which REA publication(s) the document was cited in)

Data Storage

Prior to delivery to BLM NOC in Denver, CO all source and generated datasets will be managed out of NatureServe's Network Operations Center using a working ArcSDE Geodatabase in ArcGIS 10.0. The NatureServe working geodatabase is organized using the following Feature Class categories:

CE Class I Terrestrial Coarse Filter
CE Class II Terrestrial Fine Filter
CE Class III Physical Feature (e.g., erodible soils)
CE Class IV Aquatic/Wetland Coarse Filter
CE Class V Aquatic/Wetland Fine Filter
CA Class I Wildfire
CA Class II Anthropogenic Activities
CA Class III Undesired Species
CA Class IV Climate
PL Class I Sites of High Biodiversity
PL Class II Specially Designated Areas of Ecological or Cultural Value
PL Class III General Managed Lands
PL Class IV Spatial Reporting Units
Other

To ensure that the data and products are delivered per the BLM DMP Appendix 5 directory structure, NatureServe is managing all data using an "Export Table" that serves as a lookup table between the NatureServe data source and the location in the BLM data structure. Delivery to BLM will be in an ArcGIS 10 file geodatabase using the folder structure and file naming conventions specified in BLM DMP Appendix 5. The data delivery geodatabase will be populated from NatureServe's working geodatabase using a script and the "Export Table" lookup table (See Data Processing and Document Generation).

The server for BLM REA analyses is a Windows Server 2008- 64 bit, SP 2 with two 2.66 GHz processors and 14 GB RAM. Software tools utilized at NatureServe's NOC include: ArcGIS 10.0 suite (ArcCatalog, ArcGlobe, ArcMap, ArcScene), including ArcSDE, and Microsoft SQL server 2008. The ArcGIS Desktop 10 software is kept updated with the current ESRI Service Packs. NatureServe has ensured that all project staff have access to this software through a secure Remote Desktop Connection. The NOC confirmed in February, 2011 that it will accept ArcGIS 10 products as well as ArcGIS 9.3.1.

Metadata

To ensure the development of FGDC compliant metadata that adhere to the BLM metadata template and guidelines, NatureServe has installed all patches and add-ins necessary to use ArcGIS 10 to create, edit, and export FGDC compliant metadata. The NatureServe data management lead has created detailed instructions to guide team members through the process of converting existing FGDC compliant metadata to ArcGIS 10 as well as the whole work flow for creating and exporting FGDC compliant metadata. Where possible, NatureServe will develop and implement metadata templates for all generated datasets that will both ensure compliance with the BLM metadata guidelines and facilitate the creation of metadata. The NatureServe metadata expert will review draft metadata for compliance to FGDC and BLM standards.

Draft metadata generated for each dataset will be delivered in two forms. First, metadata will be linked to datasets for viewing in ArcCatalog and will be exported to an xml file format. Second, a text format (Word and PDF file formats) draft reference document will compile metadata for all datasets, and will be incorporated into an appendix of the Ecoregional Assessment Report.

Data Processing and Generation Documentation

NatureServe will manage and deliver all spatial data using a 2-tier process, and will include both base data and developed data such as predictive distribution models or tabular score card tables relating analysis to appropriate analysis unit. Within NatureServe's data environment we maintain spatial and associated tabular information using the Schema described in the "Data Storage" section.

All vector based data will be stored within the appropriate feature group. For example, CA Class I Wildfire feature group will hold all vector data representing fire-associated layers such as recent burn boundaries. All layers (raster and vector) and tabular data names will be preceded by the related feature group code identifying a layer by its appropriate assignment, data source and, if associated, the region of analysis. For example, the vector source layer will be named CAI_BLM_Historic_Wildfire_Boundaries and can be identified as a change agent class 1 from BLM and with no analysis region association. A summary table of burn years would be named CAI_tbl_BLM_CRB_Historic_Wildfire_year_summary.

The data schema described in the "Data Storage" section is not representative of the delivery schema, but only applies to NatureServe data management. All data will be delivered to BLM based upon the required schema (BLM DMP Appendix 5). Export translation of the NatureServe schema to the required delivery schema will be monitored and performed using a NatureServe generated Python script, which will link to an SDE table within the geodatabase and include the NatureServe name and export name. The output process will track both data export and update requirements as associated fields within the SDE table. The SDE data export table will be fully representative, and inclusive, of the Master Data List as described in the "Document Management and Tracking" section.

We will maintain ongoing updating, archiving, and referencing of scripts and modeling processes associated with each numbered sub step and each data input and output. Scripts will be delivered in formats consistent with BLM requirements. For modeling conducted with published tool packages we will deliver sequential processing steps applied using those tools**.**

When custom ArcGIS scripts are developed for data processing, a draft model file (ArcGIS ModelBuilder) will accompany each dataset. For generated data derived through software packages (e.g., species distribution models derived through MaxEnt software), basic processing documentation will be provided.

Map documents will be generated based upon the NatureServe geodatabase and will utilize ArcMap templates using the above naming convention. At this time we are unable to determine whether NatureServe will develop custom map templates that adhere to the BLM guidelines for map symbology, or adapt a BLM supplied group of ArcMap templates.

Data Delivery and Review

Data Review Process

In anticipation of the BLM QA/QC process outlined in the BLM DMP, all datasets will be initially reviewed by the NatureServe team following the specific QA/QC steps in the BLM DMP Appendix 8. This initial, internal, review of all datasets produced by NatureServe will be conducted by at least two team members. All data products will be technically and thematically evaluated according to the process laid out in the Data Evaluation section above and in the BLM Deliverable QA/QC Process. **This enables the same data evaluation to be applied to both source input data and to derived data sets to be used in the REA.** This will provide an opportunity for evaluation of both derived model outputs and the relative effects of error with input data on derived models. While extensive research into the many possible sources of error in derived data sets would be desirable, in most instances, it will remain outside the scope of this rapid assessment. Qualitative review and documentation of modeler perspectives will form the basis for this evaluation, and these evaluations may be built upon by the broader research community. Deliverables will adhere to BLM specified standards for mapping (projection and datum), file formats and naming, and metadata guidelines. Datasets will be visually inspected to check for edge-matching and logical consistency with other datasets in the deliverable. Data tables will be reviewed to check for consistency and normalization of attributes, and the identification of any outliers. Uncertainty and known issues will be clearly documented. The date reviewed and the NatureServe reviewer will be documented and included in the delivery to BLM.

Metadata, DQE, and DDTF

Datasets generated by NatureServe will be delivered with complete FGDC metadata that is compliant with the BLM metadata guidelines.

Each product deliverable will be submitted with a completed Data Delivery Tracking Form (DDTF) or Map Delivery Tracking Form (MDTF) as appropriate. The tracking forms will include the information specified in the BLM DMP. The deliverable will also include the final Data Quality Evaluations (DQE) for each submitted dataset. Completion of the forms will be conducted using NatureServe's data management SharePoint site as described above, and following the procedures in our data management plan.

Data Submission for BLM Review

NatureServe will submit data as we consider it complete. Delivery will be made electronically using the BLM data portal that is currently under development, or by hand delivery of a portable external hard drive.

Data Revision

After the BLM has conducted its review and provided comments, NatureServe will respond to questions, make corrections to the datasets and metadata as required, then deliver the updated materials to BLM. We will revise data consistent with agreed scope and BLM data standards.

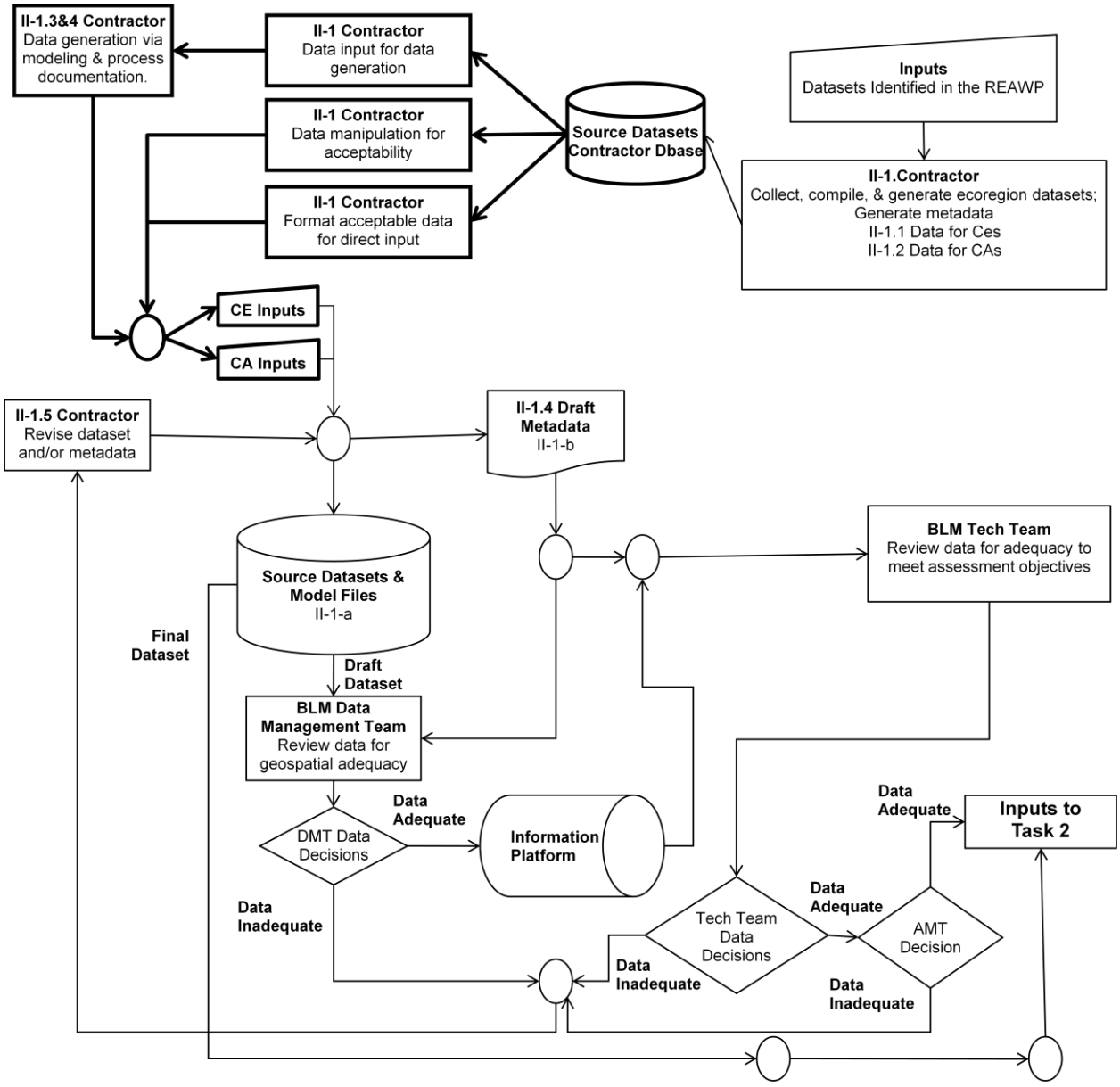
Task 5: Compile and Generate Source Datasets

Source datasets are those needed to represent Conservation Elements (CEs), Change Agents (CAs), and Places (PL) or other base data needed for modeling to address the Management Questions (MQs). The final adopted list of MQs is provided in Appendix I and CEs in Appendix II, Table 3, and Table 4; the list of CAs is incorporated in this section.

In this task we will complete acquisition, generation, and documentation of all source/input datasets for the Rapid Ecoregional Assessment (REA) and mosaic these across the ecoregion and buffer zone. Because we are conducting REAs for the adjoining Central and Mojave ecoregions, we will gain efficiency and reduce edge-match issues by creating a mosaic across both of these where applicable (e.g., for CEs and CAs that transcend both). For delivery of data we will provide the data in this form and also separated by ecoregions (with their buffers) as desired by BLM.

Figure 3. Task 5 process workflow.

The original numbering of the Phase II tasks is followed in this diagram. II-1 = Task 5; see



Conservation Elements Data Compilation/Generation

CE Class I: Terrestrial Coarse Filter

The terrestrial coarse-filter includes 18 individual ecological system types found in the CBR and identified as important to the REA (Appendix II). Each of them has mapped distributions, initially represented in the NatureServe (2009) map of Terrestrial Ecological Systems of the Conterminous United States (current distribution) and both NatureServe (Comer and Hak 2009) and LANDFIRE Biophysical Settings (potential historical distribution). LANDFIRE SClass maps will be reviewed for use in fire regime assessment. Each terrestrial coarse-filter CE will have a conceptual model developed to describe and quantify the natural and currently altered (if relevant) ecological dynamics of the system, including state-and-transition models, identification of key ecological attributes, and development of the indicators and scoring criteria for assessing ecological integrity (ecological integrity scorecard). Applicable peer-review and gray literature form the basis for these models. See Memorandum 3c for details of the ecological integrity scorecard process.

Applicable scenario(s)

These CEs will be expressed for the current scenario; and as input to the 2025 scenario.

Inputs required (see Memorandum 2c for further details about data sources)

- Land cover map (NatureServe 2009), with modifications as needed upon final expert review.
- LANDFIRE BpS
- NatureServe Biophysical Settings model for USGS Great Basin Integrated Landscape Monitoring project
- LANDFIRE VDDT models, as modified by The Nature Conservancy of Nevada – providing conceptual and tabular analytical capabilities for fire regime dynamics.
- Reference to spatial data inputs for subsequent use in ecological integrity assessment, including LANDFIRE SClass map, Landscape Condition models, Invasive annual plant location and vulnerability models, Connectivity models

Analytical process (see Memorandum 3c for further details about process)

We will extract spatial data for each coarse-filter CE to represent its potential and current footprints in the ecoregion. We will do a visual inspection of the resulting map to QC each coarse-filter distribution and refine the map as necessary. The VDDT models will be modified to include subregional variation as identified through expert review and feasibly incorporated.

Outputs (see Memorandum 3c for further details about outputs)

A raster grid map for each terrestrial coarse-filter CE. The state-and-transition models for historic range of variation (HRV, or "reference conditions"). The ecological integrity scorecard with indicators and scoring thresholds for each system.

Anticipated timeline

April-June 2011

Issues & limitations (see Memoranda 2 & 3 for further details)

We do not believe there are limitations that would preclude inclusion of these CEs for the intended uses of this REA. Limitations on input data will be documented as identified.

CE Class II: Terrestrial Fine Filter

The terrestrial fine-filter includes several hundreds of species meeting a set of criteria agreed to by the AMT (see Memos 1-3). We have developed a MS Access database for the REA to track information about each of the species, including general taxonomic information (Family, Genus, common names, informal taxonomic groupings, synonyms), global & state conservation status ranks, Federal legal status, State status, available spatial data (counts of element occurrences or observations; habitat models form GAP), whether listed in a state Wildlife Action Plan (SWAP), or as BLM Special Status.

For treatment approach in the REA, species home range sizes and habitat affinities will be reviewed, and based on those factors each species will be assigned to one of four categories: landscape/special interest species, ecologically-based species assemblage, treated within a coarse-filter ecosystem as surrogate, or local-scale species. Some species were added to the species list for the CBR based on receiving a "vulnerable" score through application of the NatureServe Climate Change Vulnerability Index (CCVI). One hundred and eighty-five (185) CBR species have been assessed with the CCVI; of those 81 have an index of vulnerable; all of these were assigned an approach category. Within our project database, each landscape/special interest species CE will be documented for inventory status within the ecoregion.

Applicable scenario(s)

These CEs will be expressed for the current scenario; and applied to the 2025 scenario. Selected species will be treated within the 2060 scenario.

Inputs required (see Memorandum 2c for further details about data sources)

- CCVI results
- Access database wherein habitat attributes and assessment approach will be captured
- Existing locational data for all CEs (observations, Heritage occurrences, agency habitat maps, modeled surfaces)

Analytical process (see Memorandum 3c for further details about process)

Species will be reviewed by taxonomic experts and assigned to one of the approach categories. The CCVI will be applied to a select subset of more common species to determine climate change vulnerability. Habitat affinities and inventory status are expert determinations documented in a database.

Outputs (see Memorandum 3c for further details about outputs)

Tabular data for all REA species documenting assessment approach, reason why each species is on the REA list, the CCVI for species where it's been applied, and other tabular data such as informal taxonomy, counts of element occurrences, and habitat relationships where documented. Documentation will be provided for inventory status and known gaps in inventories for landscape species.

Anticipated timeline

February - May 2011

Issues & limitations (see Memoranda 2 & 3 for further details)

There are several hundred species, not all will have habitat relationships fully known or documented. The subset of more common species for application of the CCVI still needs to be determined, but the intensity of work for the CCVI will necessarily limit how many taxa can have the Index applied.

Terrestrial Fine-Filter: Landscape and Special Interest Species and Habitat-Based Species Assemblages

Some species included in the terrestrial fine-filter will be assessed individually or as part of a habitat-based assemblage; the distribution of their habitat will be mapped. Most effort for conceptual and spatial modeling will be concentrated within these species. These include some 31 landscape species and 15 habitat-based species assemblages (Table 3 and Table 4). This will be done either through use/refinement of existing habitat location/suitability models or through development of new models for the ecoregion. Landscape species may be treated spatially using multiple habitat components (e.g., winter range vs. summer range). These distinctions will be established in conceptual models and then articulated as distinct spatial models. While it will not be feasible to develop models predicting occupied habitat, our goal will be to provide habitat distributions suitable for the intended uses of the REA, and reported at the level of 5th level watershed. Specialized spatial models such as NatureServe's Landscape Condition and Connectivity Models will be developed/applied as needed to support mapping of distribution and to gauge ecological integrity within current and 2025 scenarios. However, due to limitations in location data (documented populations) required for development and evaluation of inductive spatial models, we will

be unable to complete spatial models for all landscape species listed in Table 3; see numbers of available locations as an indication of species with this limitation.

Table 3. Central Basin and Range: Landscape Species Conservation Elements
Species shaded in gray are BLM focal species as identified by BLM in the SOW or during the assessment process.

Taxonomic Group	Scientific Name	Common Name	# of Heritage localities
Birds	Accipiter cooperii	Cooper's Hawk	1
Birds	Amphispiza belli	Sage Sparrow	8
Birds	Aquila chrysaetos	Golden Eagle	15
Birds	Buteo regalis	Ferruginous Hawk	70
Birds	Buteo swainsoni	Swainson's Hawk	108
Birds	Centrocercus urophasianus	Greater Sage-Grouse	38
Birds	Circus cyaneus	Northern Harrier*	4
Birds	Falco mexicanus	Prairie Falcon	37
Birds	Haliaeetus leucocephalus	Bald Eagle	61
Birds	Lanius ludovicianus	Loggerhead Shrike	4
Birds	Nucifraga columbiana	Clark's Nutcracker*	
Birds	Oreoscoptes montanus	Sage Thrasher	9
Birds	Passerculus sandwichensis	Savannah Sparrow*	
Birds	Spizella breweri	Brewer's Sparrow*	7
Birds	Tympanuchus phasianellus columbianus	Columbian Sharp-tailed Grouse	128
Mammals	Brachylagus idahoensis	Pygmy Rabbit	292
Mammals	Eptesicus fuscus	Big Brown Bat	45
Mammals	Lepus townsendii	White-tailed Jackrabbit	18
Mammals	Neotamias minimus	Least Chipmunk*	
Mammals	Odocoileus hemionus	Mule Deer	
Mammals	Ovis canadensis nelsoni	Desert Bighorn Sheep	5
Mammals	Ovis canadensis sierrae	Sierra Nevada Bighorn Sheep	4
Mammals	Tadarida brasiliensis	Brazilian Free-tailed Bat	34
Mammals	Vulpes macrotis	Kit Fox	66
Reptiles	Charina bottae	Northern Rubber Boa	36
Reptiles	Crotaphytus bicinctores	Great Basin Collared Lizard*	1
Reptiles	Hypsiglena torquata	Nightsnake*	
Reptiles	Lampropeltis getula	Common Kingsnake	4
Reptiles	Masticophis flagellum	Coachwhip	9
Reptiles	Salvadora hexalepis	Western Patch-nosed Snake	7
Reptiles	Sceloporus graciosus graciosus	Northern Sagebrush Lizard*	2

*These species do not have adequate locality data for development of habitat distribution models.

Table 4. Central Basin and Range: Species Assemblage Conservation Elements

Species Assemblages	# of Species	# of Heritage localities
Acidic altered andesite soils	2	427
Alkaline spring influenced soils	9	98
Azonal carbonate rock crevices	26	168
Azonal non-carbonate rock crevices	8	170
Basin river & riparian (higher level)	6	62
Carbonate (Limestone/Dolomite) alpine	8	43
Cave and mine roosting animals (bats)	9	543
Clay soil patches	23	919
Cliff & outcrop (higher level)	6	150
Desert scrub (higher level)	10	78
Gypsum soils	7	35
Migratory Shorebirds	7	40
Migratory waterfowl stopovers	14	7
Montane conifer	25	617
Non-carbonate alpine	4	60
Rocky outcrops	5	12
Sand dunes/sandy soils (when deep and loose)	29	544
Semi-desert shrub & steppe (higher level)	8	552
Spring mounds	5	639
Subalpine mountain-tops	5	171
Talus and Scree	16	246

Applicable scenario(s)

These CEs will be expressed for the current scenario and will provide input to the 2025 scenario. Forecasts of 2060 climate envelopes for selected species will be used for interpretation of climate-induced trends, but will not be intended for use as predicted future distributions.

Inputs required (see Memorandum 2c for further details about data sources)

- Conceptual model for each species /assemblage which articulates known habitat requirements
- Existing feature (species) point locations, and mapped distribution
- GAP or other agency predicted habitat distribution models as available
- National Ecological Systems map (NatureServe 2009) (vegetation type)
- LANDFIRE SCLASS map (vegetation structure)
- Other spatial inputs on vegetation, climate, and other biophysical constraints on species occurrence
- Landscape condition model
- Landscape connectivity model

Analytical process (see Memorandum 3c for further details about process)

Spatial models of habitat distribution will reconcile existing maps (e.g., from adjacent states, or use inductive tools (e.g., MaxEnt, Random Forest, etc.) with locational observations and biophysical layers to model predictive distribution surfaces.

Outputs (see Memorandum 3c for further details about outputs)

Predicted habitat distribution (30-90m grid and/or polygonal coverage) for each species or assemblage, for the ecoregion as a whole and areal extent of habitat summarized by 5th level HUC.

Anticipated timeline

May-June 2011

Issues & limitations (see Memoranda 2 & 3 for further details)

These models provide limited predictive power for the actual occurrence of populations, or occupied habitat of CEs, but they can provide a powerful indication of the location of habitats that are most similar to known occupied habitat.

Fine-Filter: Local Species & Species Treated Within Terrestrial Coarse-Filter

All other terrestrial and aquatic fine-filter CE distributions (see Memoranda 3 for full lists) will have distributions derived through field observations and/or Element Occurrence records from Natural Heritage programs. Species presumed to be addressed in the REA through assessment of coarse-filter CEs (all freshwater aquatic species, and some terrestrial species), and those local-scale species to be treated within summaries by watershed, will require no additional modeling steps. Summary statistics of known observation / occurrences by 5th level HUC will be the primary output. We anticipate providing summary statistics by HUC, including number of known locations for species grouped into categories used as criteria for selecting species to address in the REA (e.g., NatureServe status ranks, protective legislation, BLM sensitive species listings, etc.)

CE Class III: Physical Feature - Sensitive Soils

As a desired CE, sensitive soils were defined by BLM. Sensitive soils are those which are extremely susceptible to impact and difficult to restore and reclaim, including those with high erosion potential, shallow depths, high salinity, high gypsum content, low water-holding capacity, or hydric qualities (Bryant, L. BLM internal communication). No spatial data exist to specifically map these soils, so our approach is designed to provide a deductive model distribution for each soil type with these characteristics; given the best available data at any given location.

Applicable scenario(s)

Being enduring physical features, these CEs will be expressed for all scenarios.

Inputs:

- Where available, the SSURGO 1:24,000 dataset provided by NRCS
- In portions of the study area for which SSURGO is unavailable, 1:250,000 scale STATSGO data will be utilized
- 10-meter resolution digital elevation model (DEM), processed for landform characteristics (slope, aspect, concavity, surface flow character, etc)

Analytical process (see Memorandum 3c for further details about process)

As a first step, sensitive soils will be identified separately based on (a) erosion potential (water and wind) (b) droughty characteristics, (c) hydric characteristics, (d) salinity (excess salt and excess sodium), (e) gypsum content, and (f) rooting depth by querying the SSURGO or STATSGO database using the NRCS Soil Viewer in GIS. A GIS join will then be performed to generate a single shapefile of sensitive soils that contains attribute information specifying the source of vulnerability.

Outputs (see Memorandum 3c for further details about outputs)

A summary polygonal coverage showing location of all sensitive soil areas with embedded attributes for the relative degree of sensitivity for characteristics where that is feasibly reported.

Anticipated timeline

May 2011

Issues & limitations (see Memoranda 2 & 3 for further details)

SSURGO provides a moderately good means for identifying sensitive soils in those locations where it is available. Where SSURGO is not available, our ability to accurately map sensitive soil areas is somewhat compromised. Where SSURGO is not available, STATSGO will be used. In conjunction with those data sources, DEM-derived landform data will also be utilized. While soil attributes analogous to those available from SSURGO can be used to define sensitive soils based on STATSGO map units, the

coarse resolution of that data increases the potential for errors of omission regarding occurrences of sensitive soils in these areas. It is beyond the scope of this REA to incorporate landscape context (e.g., wind pattern) into the calculation of wind erosion potential. There will undoubtedly be error introduced by the use of these spatial inputs of distinct spatial and thematic resolutions. Investigation of this proposed method has thus far indicated that these issues are likely to be manageable for the purposes of the REA.

CE Class IV: Aquatic Coarse Filter

We will review and refine the current mapped information and augment it with data (where available) from National Wetland Inventory (NWI) for wetlands locations and NHD Plus (1:100K and 1:24K scale data) for streams, lakes, intermittent washes, and playas. Where NHD data fall outside of NatureServe ecosystems and NWI polygons, we will use elevation to determine the CE type to which to assign each stream reach, lake, wash, etc. Data on desert spring and seep locations exist primarily for Nevada, but we will continue to identify data from surrounding states.

Each aquatic coarse-filter system will have a conceptual ecological model developed to describe and quantify the natural and currently altered (if relevant) ecological and hydrologic dynamics of the system; including identification of key ecological attributes, and development of the indicators and scoring criteria for assessing ecological integrity (ecological integrity scorecard). Applicable peer-review and gray literature forms the basis for these models. The ecological integrity indicators for aquatic CEs have been updated from Memorandum 3, incorporating comments from the USGS and refinements in methods: the indicators Nutrient/ Pollutant Loading Index, Surface Water Runoff Index, and Sediment Loading Index have been combined into the Landscape Condition Model Index. The indicators Index of Hydrological Integrity, Stream Nutrient Condition: Nitrogen and Phosphorus Availability, and Native Fish Composition Index have been removed due to a lack of data and feasibility for the assessment. See Appendix III for revised text and scorecard table.

Applicable scenario(s)

These CEs will be expressed for the current scenario and will provide input to the 2025 scenario.

Inputs required (see Memorandum 2c for further details about data sources). Data required for Aquatic Invasives, which will be an integral part of Aquatic Coarse-filter EIA, are listed in the Aquatic Invasives section (below)

- National Ecological Systems map (NatureServe 2009) (contains all Land use, Land Cover and Ecological Systems)
- NWI for wetlands locations
- NHD, NHDPlus, USGS supplementary data for NHDPlus on baseflow and overland flows, StreamStats
- Spring and seep locations
- NED 30m
- Road GIS layers for road density (especially dirt roads if data becomes available)
- Basin Characterization Model output data from USGS Flint and Flint (2007) or as updated by authors with newer data
- State, federal stream bioassessment benthic macroinvertebrate O/E scores
- "F" metric (for flow modification) and riparian connectivity metric from Theobald et al. (2010)
- State Natural Heritage program data
- National Atmospheric Deposition Program data
- National Inventory of Dams, state dams databases
- USEPA and State discharge permit data
- USGS Southwest Principal Aquifers (SWPA) study data
- USEPA and State Impaired Waters data

Analytical process (see Appendix III for further details about process)

We will extract spatial data for each aquatic coarse-filter CE to represent its footprint in the ecoregion. Each CE distribution will be an overlay of NHD waters, NatureServe Ecosystems and NWI wetlands, and spring/seep data as applicable. Each combination can be clipped to show the distribution of that CE. We will make necessary corrections to the NatureServe Systems Layer. We will also overlay with the NWI maps to determine if there are additional wetland areas that fall outside the first two layers. Where the two overlap we will use the NatureServe System layer. We will do a visual inspection of the resulting map to QC each coarse-filter distribution and refine the map as necessary.

We will complete the development of ecological indicators for each of the nine CEs (see Appendix III for updated scorecard example): 1) Level one indicators (landscape-level land use); 2) Level 3 indicators (benthic invertebrate); 3) hydrologic change indicators to be processed for each CE, including data processing to calculate the likely degree of change to surface and groundwater flows and clipping indicators of connectivity to the appropriate Basin boundaries. (See details as outlined in Appendix III).

Outputs (see Memorandum 3c for further details about outputs)

A raster map for each aquatic coarse-filter CE. The ecological integrity scorecard with indicators and scoring thresholds for each system and data compiled for each metric. Summarized area of each aquatic CE by 5th level HUC, areal extent by HUC and for the ecoregion.

Anticipated timeline

May-June 2011

Issues & limitations (see Memoranda 2 & 3 for further details)

We do not believe the limitations preclude inclusion of these CEs. However, there is not adequate data to represent historic wetland CE distribution. We will not conduct a comparison of historic to current distribution. This analysis will be current distribution and status only. We also know that not all springs will be represented.

Change Agents Data Compilation/Generation

CA Class I: Wildfire

Wildfire Effects on CE Ecological Integrity

Fire regime characterization enables both tabular and spatial analysis to investigate the relative degree of departure in successional trajectories for a given fire-associated CE. This assessment will apply primarily to terrestrial coarse filter CEs that are naturally fire-dependent and/or known to have had fire regimes introduced in recent decades. Conceptual state-and-transition models provide the mechanism to state assumptions and document current knowledge of fire regimes. Tools such as Vegetation Dynamics Development Tool (VDDT) enable scenario analysis to characterize expected proportions of successional stages (e.g., per 5th level watershed). Comparison of expected successional stage proportion with observed proportion provides an indication of departure and provides input to ecological integrity scorecards.

Applicable scenario(s)

This analysis will be expressed for the current scenario – using mapped information - and carried forward into the 2025 scenario (using only tabular summaries). Climate forecasts (see subsequent discussion under climate change effects) will be used to modify future fire probabilities for tabular summaries applicable to the 2060 scenario.

Inputs required (see Memorandum 2c for further details about data sources)

- Current CE distribution for applicable CEs
- LANDFIRE and subsequently updated VDDT models for each CE
- LANDFIRE SClass maps for relevant CEs
- Climate forecast summaries for the range of each applicable CE

Analytical process (see Memorandum 3c for further details about process)

Literature and expert-based characterization of fire regime and successional dynamics; refining existing information for application to the ecoregion. Subregional models may be developed as indicated and feasible. Output from climate forecasts will be used to establish plausible adjustments to fire regime probabilities for 2060 scenario analysis. Sensitivity analysis will be completed for each model.

Outputs (see Memorandum 3c for further details about outputs)

VDDT models for all applicable CEs, updated and tested for application to current, 2025, and 2060 scenarios.

Anticipated timeline

April-June 2011

Issues & limitations See Memoranda 2 and 3 for further details.

Current limitations exist for gauging current departure for selected CEs where LANDFIRE SClass data and invasive annual plant models are deficient. Integration of climate forecast information to adjust fire probabilities applicable to the 2060 scenario remains experimental. Because we anticipate that the available data will not result in a clearly understood relationship between changes in climate and fire probability, we will change fire probabilities based on the proportional change in the distribution of temperature shifts to simulate a range of fire probabilities. We will then be able to report on the range of changes in successional classes by HUC 10. While we will investigate recommended methods for incorporating biennial precipitation patterns into fire probabilities within VDDT, access and use of climate data at this temporal resolution is likely outside of the scope of this REA.

CA Class II: Development

Urbanization

Several MQs deal with impacts of CEs from common forms of urban/exurban development. One set of models deals with the established scenarios (current, 2025, 2060).

Inputs

Current and forecasted housing densities from ICLUS/SERGoM

Analytical process

No new analysis is required with this data set in preparation for task 6 assessment, where it will be overlain with CE distributions.

Outputs

- Map of current urban development, categorized by housing/building densities
- Map of 2025 forecasted urban development; same categories
- Map of 2060 forecasted urban development; same categories

Anticipated timeline

June, 2011

Issues and limitations

Strengths and weakness of this data set were reviewed in previous memoranda.

Landscape Condition Models

Landscape condition models incorporate multiple stressors of varying individual intensities, the combined and cumulative effect of those stressors, and some measure of distance away from each stressor where negative effects remain likely. They can be customized for application to particular CEs or groups of ecologically similar CEs.

Based on expert judgment and the literature, we established an initial generic landscape condition model that will be used as a starting point for customized models in the REA. We selected a subset of CAs (see Memorandum 3c, Table 17) and assigned site and distance intensity scores, between 0.0 and 1.0 to represent our assumptions of stress induced by each CA on CEs. A relative site intensity score near 0.0 indicates our assumption that the CA induces very high levels of stress on nearby ecosystems (i.e.,

removes nearly all condition value). Scores closer to 1.0 are assumed to induce a minimal amount of stress (i.e., retains nearly all condition value). Similarly, distance (offsite) effects from CAs are set using a distance decay function, scaled between 0.0 and 1.0, to represent our assumptions of decreasing stress effects of each CA with distance away from each impacting feature (see Memorandum 3c, Table 18 for the proposed scores for site and distance intensity).

Applicable scenarios: current

Inputs: All development and terrestrial invasive species CAs

Analytical process: NatureServe will establish intensity scores for CAs, using scientific literature to calibrate distance effects wherever possible. Site and distance intensity scores may be reviewed and modified by AMT science members and partners. The source of information for the scores will accompany the process documentation and the output metadata. The mapped or modeled CA distributions will be combined and transformed into a single raster surface. We will use the Landscape Condition Modeler, a Python-based toolbox for ArcGIS 10 written by NatureServe.

Outputs: A continuous raster surface with values from 0-1 representing relative CA induced stress on the landscape. When assessing ecological integrity of CEs, we can address attributes of the CE itself using indicators that best distinguish a degraded state from a sustainable state. For CAs, we will identify attributes that reflect the types and degrees of stressors that may be impacting the condition of the system which may be driving changes.

Anticipated timeline: June, 2011

Issues: The concept of landscape condition modeling is a simplified rendering of field conditions summarized to relative indices that take into account factors that may be readily expressed on maps. The model may not reflect all observed condition levels for features on the landscape and does not directly incorporate field observations of condition although these can be used to calibrate the model.

Energy Development

Several MQs deal with traditional and renewable energy development. One set of models deals with the established scenarios (current and 2025) while another set is free of a particular timeframe and assesses the total potential energy development footprint.

Inputs

Existing/approved renewable and extractive energy facilities; Proposed/in-review renewable and extractive energy facilities; Potential renewable and extractive energy zones

Analytical process

The current and 2025 energy scenarios are the products of combining existing source data. The energy potential relies on sophisticated models developed by NREL and the Great Basin Center for Geothermal Energy.

Outputs

- Map of current energy development
- Map of 2025 (proposed & current) energy development
- Map of proposed, current, and potential energy development

Anticipated timeline

May-June, 2011

Issues and limitations

An AMT member observed that the majority of large renewable energy projects are occurring on parcels of state or private land. The limitations of the REA scope are such that at this time we can only include projects proposed on BLM lands. Unless state and private projects are large enough to invoke a NEPA review, these projects are generally not tracked centrally. Renewable energy specialists from the AMT have indicated that not all proposed energy projects are likely to come to fruition. This will also not reflect any likely projects filed with the BLM after May 1, 2011.

Mines and Refuse Management

The mines and refuse management CA includes existing features whether in operation or not with a discernible footprint. Data generation is required to map these feature footprints because existing data only contains point locations.

Applicable scenario(s)

These CAs will be expressed for the current scenario and carried forward into future scenarios but we will not model projected future development. If planned/approved new development is provided, it will be included in the 2025 scenario.

Inputs required (see Memorandum 2c for further details about data sources)

- Existing feature point locations
- National Ecological Systems map (NatureServe 2009)

Analytical process (see Memorandum 3c for further details about process)

We will intersect the existing point map with the land cover map and extract corresponding areas of barren land cover classes to represent the feature footprint. We will do a visual inspection of the resulting map to identify features with no corresponding barren area and those with excessive footprints due to naturally barren conditions. Each such situation will be analyzed and treated appropriately.

Outputs (see Memorandum 3c for further details about outputs)

A polygon map of mine and land fill features

Anticipated timeline

April-May 2011

Issues & limitations (see Memoranda 2 & 3 for further details)

During the testing, we found that this method would likely underestimate significantly the effects of historic mining areas. The method may also pick up roads, urban areas, etc that may be peripherally related to mining activity.

Recreation Development

One MQ deals with recreational use. One set of models deals with recreation assuming motorized travel, another set assumes passive (hiking) travel, and a third deals with aquatic recreation on streams and reservoirs.

Inputs (see Memorandum 2c for further details about data sources)

Existing recreational sites; transportation infrastructure; highway traffic; city population from 2010; topography/slope; visitation records from USFS, NPS.

Analytical process (see Memorandum 3c for further details about process)

The recreational development model is a product of combining existing source data and predictive modeling, which we will compare to observed visitation use (where available).

Outputs (see Memorandum 3c for further details about outputs)

- Map of current estimated recreation use levels for motorized recreation
- Map of current estimated recreation use levels for non-motorized recreation
- Map of estimated recreation use levels given population estimated for 2025 (proposed & current)

Anticipated timeline

June-July, 2011

Issues and limitations

Two critical datasets from the BLM are anticipated: a) linear disturbances to pull out the roads/trails on public lands; and b) travel management and resource management plans to identify intensive recreational (especially motorized) recreation. We also anticipate working directly with AMT and field scientists to ensure parameterization of the models are reasonable. To that end, we anticipate a face-to-face meeting with a set of BLM personnel, to be scheduled in May/early June 2011.

CA Class III: Invasive Species

Terrestrial Invasive Species

There are over 50 documented invasive change elements occurring within the CBR. However, there is not a comprehensive extent representing the complete analysis area for any one, or group of, invasive species change agents. The majority of the invasive CAs occur in disturbance niches, and often have many similar habitat requirements. To leverage existing location records of invasive CAs we will derive up to three risk models representing similar floristic groups: annual grasses, biennial and perennial forbs, and woody riparian species. We will develop a conceptual model for each Invasive Group utilizing a combination of inductive and deductive modeling methodology to define area of highest risk.

Applicable scenario(s)

This CA will be expressed for the current scenario and carried forward into future scenarios but we will not model projected increases in invasive CAs.

Inputs required (see Memorandum 2c for further details about data sources)

- Peterson cheatgrass map
- LANDFIRE sample points
- Southwest Exotic Mapping Program (SWEMP) 2007 Dataset
- Soils
- NHD Plus hydrology
- NED and derivatives
- 1-KM^2 annual grass risk model (Bradley 2009)
- National Ecological Systems map (NatureServe 2009)
- Burns from inter-agency fire perimeter data
- WorldClim bioclimatic variables (potential for inductive models)

Analytical process (see Memorandum 3c for further details about process)

We will cluster existing samples from all existing dataset into a comprehensive database representing each Invasive Group. Using the comprehensive database we will develop models representing a probability surface of potential risk using, but not limited to, inductive modeling with Maximum Entropy and CART methodology.

Outputs (see Memorandum 3c for further details about outputs)

A set of maps depicting vulnerability to invasive Change Agent groups.

Anticipated timeline

April-June 2011

Issues & limitations (see Memoranda 2 & 3 for further details)

We do not believe that limitations preclude inclusion of these CAs.

Aquatic Invasive Species

Development of aquatic invasive species impact indices by state and federal agencies is sorely lacking, even though ample funding is available. Impacts from invasive species are considered to be of equal importance with habitat loss and global climate change as the primary causal factors responsible for the world's rapidly decreasing biodiversity and altered ecosystem functioning. Given the acknowledged negative ecological impacts of aquatic invasive species and the scarcity of aquatic invasive species bioassessments, we will create an index of aquatic invasive species impact, which can be reported for each 8 and 10-digit HUC.

The Aquatic Invasive Species Index originally proposed in Memorandum 3c has been simplified and improved to streamline the spatial analysis and to better answer MQs. Both the Within HUC and Surrounding HUC indices have been modified. We condensed three Landscape Context metrics (road density, recreational use, and urbanization) into the Landscape Condition Model Index metric for level of

human activity in the Within HUC index. We also slightly modified several other metrics in the Within HUC index.

The Surrounding HUC index has been modified significantly more than the Within HUC index. We changed the Surrounding HUC index to the Potential Future Invasive Index; this index will be calculated for two time frames: 2025 and 2050. We reduced the number of metrics from thirteen metrics to three metrics: number of novel invasive taxa, number of surrounding infected HUCS, and degree of human use. We eliminated the three "invasiveness ecology" metrics because all of the invasive species in this assessment score as "highly" invasive. The four "Proximity to infection and connectivity" metrics were condensed to a single measure of the number of immediate adjacent infected HUCs for the 2025 scenario and the number of infected HUCs at a greater distance for the 2050 scenario. The distance measure for the 2050 scenario is still to be determined. Four metrics for human activity have been replaced by the Landscape Condition Model Index. We also eliminated the "time since first invasion" because this metric is used in the Within HUC index and other metrics implicitly incorporate time. See Appendix IV for the new revised Aquatic Invasive Index. (This replaces the information supplied in Appendix IV in Memorandum 3c).

Inputs required

- USGS NAS
- USGS didymo database
- Natural Heritage Programs data
- National Ecological Systems map (NatureServe 2009) (land use)
- NHD hydrology
- Southwest Exotic Mapping Program (SWEMP) 2007 Dataset

Analytical process (see Appendix IV for further details about process)

We will compile data required to calculate the Aquatic Invasive index for within-HUC and surrounding-HUC scores.

Outputs (see Appendix IV for further details about outputs)

HUC 10 and HUC 8 summary of number of invasive species present

Anticipated timeline

April-June 2011

Issues & limitations (see Memoranda 2 & 3 for further details)

We do not believe the limitations preclude inclusion of these CAs.

CA Class IV Climate Change

Climate change data and assessments for the REA are complex. In Task 5 we conduct analyses of the climate data to generate inputs for many MQ assessments in Task 6. Because of the complex interactions of climate change data, CE distributions, and other CAs, we describe the key climate change work here in Task 5.

Climate Space Trends for Terrestrial CEs

Our objectives in assessing the ecological impacts of climate change are to identify a robust climatic baseline for the CBR ecoregion (1900-1980), to analyze the spatial and temporal nature of recent (1995-2010) and future (2020-2040; 2050-2070) climate trends relative to ecoregional watersheds and the distributions of selected terrestrial CEs. The latter analysis will aim to determine which CEs are most vulnerable to climate change impacts and to characterize the spatio-temporal nature and degree of certainty of that vulnerability.

Climate change is predicted to have a number of effects on individual terrestrial CEs, and these effects are likely to vary considerably across the distribution of a given CE within the ecoregion. The MQs involving climate change require two different methods of assessing climate change impacts: 1) a climate space trends analysis which will examine how a specific terrestrial CE's climate envelope is

changing and the magnitude of departure that future climates represent compared to historical baselines, 2) a model of spatial distributions of the bioclimatic envelope for each CE which will show how its climate-defined range is predicted to shift under future climates. In both analyses, we use multi-model ensembles to quantify the degree of agreement across alternative climate models.

Table 5 shows the climate datasets we will be using in these analyses; Table 6 lists the climate variables being provided in the Hostetler (USGS 2010) climate dataset.

Table 5. Climate datasets to be utilized in the CBR REA

Dataset	Timeslices	Resolution	GCMs	Variables
PRISM	Baseline: 1900-1980 Recent: 1980-1995 1995-2010	4km	None – observed climate surface	Minimum Temperature Maximum Temperature Total Precipitation
EcoClim	Future: 2020-2040 2050-2070	4km	bccr_bcm2_0 cccma_cgcm3_1 miroc3_2_medres csiro_mk3_0 csiro_mk3_5 ukmo_hadcm3 inmcm3_0 ipsl_cm4 mpi_echam5 cnrm_cm3 miub_echo_g mri_cgcm2_3_2a giss_model_e_r ncar_pcm1 gfdl_cm2_0 gfdl_cm2_1	Minimum Temperature Maximum Temperature Total Precipitation
Hostetler	Baseline: 1968-1999 Recent: Future: 2015-2030 2045-2060	15km	ECH5 GFDL NCEP	* see list below

Table 6. USGS / Hostetler climate variables to be utilized in the CBR REA

Elev	Elevation
ET (A,M)	Total evaporation from open water, land and vegetation.
GDD10 (A,M)	Growing degree days, base 10°C
GDD5 (A,M)	Growing degree days base 5°C
P2 10 (A,M)	Number of precipitation events 2 < P < 10 mm per 6hr period
P2 (A,M)	Number of precipitation events < 2 mm per 6hr period
P100 (A,M)	<100mm per 6 hr period
P10_25 (A,M)	Number of precipitation events 10 < P < 25 mm per 6 hr period
P25_50 (A,M)	Number of precipitation events 25 < P < 50 mm per 6 hr period
P50_100(A,M)	Number of precipitation events 50 < P < 100
QA (A,M)	Anemometer specific humidity

RT (A,M)	Total precipitation
SMU (A,M)	Top layer soil model moisture
Snow (A,M)	Snow water equivalent
SWN (A,M)	Net solar radiation absorbed
TA (A,M)	2-meter air temperature averaged over the model grid cell for the given time period.
TAMAX (A,M)	Average maximum anemometer temperature
TAMIN (A,M)	Average minimum anemometer temperature
VEG	BATS surface type codes
TAMAXA (M)	Absolute maximum anemometer temperature
TAMINA (M)	Absolute minimum anemometer temperature

Our modeling work for climate change was detailed in Memoranda 2c and 3c, in summary, the steps that will be completed during Task 5 are:

1. Climate Space Trend Analysis. As detailed in previous memos, we will map future climate space as derived from a large number of climate models vetted for the IPCC's 4th Assessment Report (IPCC 2007). The primary time period for this analysis will include the mid-century period (2050-2070) summarized by 4th level watersheds. Time permitting, we will also include a near-term future time step (2020-2040). Only the A2 greenhouse gas emissions scenario is being examined in the climate space trend analyses. These graphs will demonstrate the magnitude of change between modeled future seasonal climates and observed historical and current climates, as defined by seasonal characterization of temperature and precipitation.

2. Spatial Trends in CE Climate Envelopes: In order to document and interpret potential effects of climate change to individual CEs, we will use statistical correlations between observed locality data and current climate, and then forecast this relationship to project potential future envelope distributions based on future climate scenarios. Given data in hand, this analysis will likely apply to approximately 30 terrestrial CEs. This approach does not presume that current distributions delineate the biophysical limits of each CE distribution, but rather that they reflect central tendencies within that distribution. This step will use multiple datasets: PRISM 4 km for current climate, USGS 15km downscaled climate model outputs (USGS-CD), and EcoClim, a future climate dataset created in the CA Academy lab that has been downscaled to 4km PRISM. Using Maxent, a species distribution modeling algorithm, we will generate two sets of current bioclimatic envelopes. The first set will use PRISM 4 km monthly data, for temperature and precipitation only. The second set will use the NCEP re-analysis of the USGS-CD 15km for a mid-20th century time slice – 1968-1999 – representing the baseline version of the USGS-CD (this dataset is still being generated). The USGS data includes many additional variables beyond temperature and precipitation, such as soil moisture and solar radiation, but at coarser spatial resolution. Per Memorandum 3c we will create 2 sets of range shift models, 1 from EcoClim and one from the USGS-CD and 3 time series for each set--1968-1999, 2015-2030, and 2045-2060.

Applicable scenario(s): The primary focus of this analysis is the 2060 scenario, although selected outputs will be applicable to the current and 2030 scenarios

Inputs required (see Memorandum 2c for further details about data sources)

- PRISM climate data
- CA Academy EcoClim 4km climate data (Hamilton)
- USGS 15km climate data (Hostetler).

- 4th level watersheds
- Locality data for selected CEs

Analytical Process: See above details and Memoranda 2 and 3c

Outputs (see Memorandum 3c for further details about outputs)

Anticipated timeline

May-July 2011

Issues & limitations (see Memoranda 2 & 3 for further details)

A key unresolved issue is whether BLM wishes to purchase the 800m resolution PRISM data. This issue is detailed in previous memoranda and was discussed in detail at AMT workshops. Unless otherwise instructed by BLM, we will proceed without this data set.

Climate-Hydrologic Effects Assessment

We will also assess the impacts of climate change on each aquatic coarse-filter CE. The assessment of the potential effects of climate change on aquatic coarse-filter CEs will follow that described above for the assessment of terrestrial coarse-filter CEs in most respects, in order to assess the Climate Space Trend for the aquatic coarse-filter CEs. The steps involved for each CE are:

1) Establish the historical baseline bioclimatic envelope (summarized by 4th level watershed) using data on monthly Minimum Temperature, Maximum Temperature, and Total Precipitation;
2) Establish the current bioclimatic envelope for the same variables and compare them graphically to the historic baseline;
3) Estimate the future bioclimatic envelope for the same variables and compare this to the historic and current conditions; and
4) Qualitatively assess the potential consequences of these departures for watershed hydrology, specifically for recharge, runoff and evapotranspiration rates.

The assessment for aquatic coarse-filter CEs will differ in three significant ways from that for terrestrial CEs:

- The baseline period for the aquatic coarse-filter CEs will be 1940-1980, to be consistent with the data incorporated into the USGS Basin Characterization Model (Flint and Flint 2007; see below).
- Second, the assessment for aquatic coarse-filter CEs will not address the potential shifts in climate-defined ranges. Current knowledge and methods are not adequate to support such an analysis for aquatic ecosystems.
- Third, the Climate Space assessment for the aquatic coarse-filter CEs will use different spatial units. The mapped distributions of terrestrial coarse-filter CEs establish large areas across which the grid of climate data (e.g., 4km PRISM) can be overlaid to identify all climate grid units within the ecoregion in which each terrestrial coarse-filter CE is present based on ground-based plot data. The Climate Space approach for each terrestrial coarse-filter CE then plots the climate space for its ground-based plot locations as a set of graphs of temperature vs. precipitation for three ecological seasons (early growing, late growing, non-growing), and the annual average. In contrast, most mapped occurrences of aquatic coarse-filter CEs consist of linear and point features – e.g., riparian-stream networks, springs, wetlands – rather than as areas within which we have plot locations over which one can lay a grid of climate data. Further, every aquatic coarse-filter CE depends for its hydrology not on climate conditions immediately overhead, but on the climate conditions that affect the entire surface watershed and/or groundwater zone from which it receives its water. *As a result, the appropriate spatial frame for assessing the potential effects of climate change on aquatic coarse-filter CEs is the zone(s) within each HUC primarily responsible for producing surface runoff and groundwater recharge*. Otherwise, the same method of seasonal graphic characterization will apply.

Flint and Flint (2007) used their Basic Characterization Model methodology to identify the land surface areas principally responsible for producing surface runoff and groundwater recharge across the entire Central Basin and Range ecoregion (and beyond), on a 270m grid. As would be expected for the arid regions of the interior western U.S., runoff and recharge arise primarily at higher elevations. At the same time, their findings confirm the perhaps obvious assumption that evapotranspiration plays a dominant role in watershed hydrology at lower elevations. These findings suggest that the bioclimatic envelope for each aquatic coarse-filter CE should be delineated and assessed using *the 6th Level HUC watersheds in which each CE occurs AND all other 6th Level watersheds that lie uphill from these core HUCs within the same 5th Level HUC watershed*. For alpine and montane riparian-stream CEs the resulting spatial frame will be nearly identical to the spatial frame that would be defined using the runoff and recharge zones identified by Flint and Flint (2007). For lower-elevation CEs – including spring and seep systems, natural lakes, playas, and lower-elevation riparian-stream systems – the resulting spatial frame will include portions of the landscape within a 5th Level HUC across which ET dominates over runoff and recharge. The results using the 6th Level HUCs will then be summarized by 5th Level HUC.

Applicable scenario(s): The primary focus of this analysis is the 2060 scenario, although selected outputs will apply to the current and near-term scenarios

Inputs required (see Memorandum 3c for further details about data sources)

- Climate data as for terrestrial climate change assessment
- Flint and Flint 2007 available models

Analytical process (see Memorandum 3c for further details about process)

Task 5 activities will include acquisition and testing of Flint and Flint data, and assessment of bioclimate envelopes for 6th Level HUCs, along with prototyping of analysis and reporting applications for the REA.

Outputs (see Memorandum 3c for further details about outputs)

5th level HUC summaries of climate departure applicable to assessment of each aquatic CE, and qualitative assessment of how the projected changes in climate would likely affect watershed hydrology, specifically runoff, recharge, and evapotranspiration.

Anticipated timeline

May-July 2011

Issues & limitations (see Memoranda 2 & 3 for further details)

Geographic limitations of available models from USGS will preclude comprehensive reporting for portions of CBR along its northern border, within the "buffer" zones added to the CBR boundary. Mapping of recharge zones along mountain front areas and across basin floors (e.g., along washes) may be weak in the Flint and Flint analysis, but use of 6th Level HUCs as described above will incorporate these same areas and so counter this possible weakness in the mapping of recharge zones.

Places of Conservation and Management Interest Data Compilation

Certain MQs address types of terrestrial and aquatic geographic areas and features identified for their conservation value or otherwise designated for conservation management. During Task 5 we will complete the acquisition of the data for the classes of places described below.

PL Class I[1]: Sites of High Biodiversity

Areas of High Biodiversity are represented in the data by previous analyses characterizing locations with concentrated at-risk biodiversity or locations where a prioritization exercise has identified areas of high conservation significance. Criteria for previous prioritization exercises vary, and those variations can reflect on their suitable usage for the REA. This class may overlap spatially with the subsequent two PL classes (II and III) but they differ in that the latter categories include established legal boundaries for

[1] We refer to these classes as *Places*, being neither a CE nor CA; thus the PL abbreviation below.

land and water units (e.g., ACECs). Areas of high biodiversity significance most frequently imply more flexible boundary definition and suggest the need for future field verification prior to settling upon new legal or management designations. Types falling within this class and activities for Task 5 include:

- Crucial habitats, as defined through the Western Governors' Association (WGA) Western States Decision Support System (DSS) efforts, often fall into this category. We have yet to evaluate these data, as they will become available through the Southwest DSS effort.
- Ecoregional assessments (ERAs) conducted by The Nature Conservancy (TNC) include the identification of priority conservation areas. These "portfolio sites" equate with areas of high biodiversity. The primary TNC effort for the CBR includes their Great Basin assessment (Nachlinger et al 2001), but adjacent assessments include sites that overlap the CBR boundaries. By compiling information on "coarse-filter" and "fine-filter" CEs, evaluating their condition, establishing representation goals, and factoring in existing protected areas, ERAs identified an efficient land allocation to achieve their stated representation goals. NatureServe has acquired the entire U.S. dataset from TNC to represent these sites in the REA. **We recommend using these site boundaries as a potential spatial reporting unit for this REA.**
- Important Bird Areas identified by Audubon and by the American Bird Conservancy. In many instances, the IBAs were already factored into previous TNC assessments. However, as we acquire these data, we will determine their relative applicability to this REA.

PL Class II: Specially Designated Areas of Ecological or Cultural Value

Many of these areas are special classifications of BLM and US Forest Service lands: wilderness areas, wilderness study areas, and the region's only national conservation area, the Black Rock Desert-High Rock Canyon Emigrant Trails. We will also take into account unique BLM lands distinctions such as Areas of Critical Environmental Concern (ACEC). By their special nature, USFWS National Wildlife Refuges and National Parks are also included in this category. All of these data are best represented in the Protected Area Database of the U.S. (PADUS) version 1.1 which has been obtained and evaluated. This dataset will be verified against the BLM Surface Management Agency (SMA) maps.

PL Class III: Other Managed Lands

Other managed lands include the majority of the area of federal or state managed lands in the CBR characterized by management for multiple uses. The AMT has requested that we use BLM's SMA maps provided by the NOC to identify all managed lands. These land types will only be used for map context as no MQ address these lands. They may serve as important reporting units for BLM internally (e.g., by FO and for work with state and other federal partners).

Task 5 Deliverables

- Resource and CA Source Datasets and Model Files (II-1-a): NatureServe will deliver datasets and model files including source and generated datasets identified in the REAWP that meet BLM geospatial requirements. When custom ArcGIS scripts are developed for data processing, a draft model file (ArcGIS ModelBuilder) will accompany each dataset. For generated data derived through software packages (e.g., species distribution models derived through MaxEnt software), basic processing documentation will be provided. Draft versions of each dataset will be delivered to the BLM (as electronic copies) as soon as practical after generation for review.
- Draft Metadata (II-1-b): NatureServe will deliver draft metadata generated for each dataset in two forms. Metadata will be linked to datasets for viewing in ArcCatalog and will be exported to an xml file format. A text format (Word and PDF file formats) draft reference document will compile metadata for all datasets, and will be incorporated into an appendix of the Ecoregional Assessment Report in Phase II Task 3 (II-3-c).

Task 5 Schedule

- Per agreement with BLM, NatureServe initiated some activities of Task 5 during Task 4 beginning in late March 2011 for items considered fully settled.
- NatureServe will deliver draft datasets as soon as completed for ongoing review and will deliver complete electronic copies of draft datasets and metadata for BLM review within 60 days after the final REAWP (365 days after the Task Order award)

Table 7. Summary schedule for Task 5

Item	Date
Draft REA datasets & draft metadata will be completed and delivered	June 30, 2011
BLM review	July 5, 2011

Task 6: Conduct Analyses and Generate Findings

Overview of Task 6

Following Task 5 data generation for CAs and CEs, Task 6 focuses on the assessments to be conducted to answer the MQs. Details for each MQ assessment are provided in Appendix I and indicate the following key information (extracted from an Excel spreadsheet that contains the full history of MQ changes and notes from previous tasks):

- MQ tracking number: a fixed number applied to all MQ that were accepted for assessment as of end of Task 3.
- MQ Group: original themes by which the MQs were organized.
- Task 6 Assessment Type: the assessment approach that will be used in Task 6.
- MQ description: the description of the MQ as will be assessed.
- Original MQ: the original description of the MQ.
- Data: the description of the data to be used in the MQ as established in Task 2 (or since supplemented).
- Model/Analytical type: the categories of models from Task 3 that will be used to answer the MQ. These are general categories, more details and diagrams for the models were provided in Memorandum 3c.
- Reporting unit: the unit at which MQ results will be reported.
- Reporting metrics: the numeric values used to answer or support the MQ (e.g., many MQ simply ask where a CE or CA exists, supporting metrics may also provide amount of area).
- Comments: these are provided in the REAWP draft to indicate remaining MQ questions, provide further definitions to the MQ, or record AMT decisions at conclusion of Task 4.

Reporting units will be provided for each MQ per above, but in general follow reporting requirements established by BLM in the SOW: Landscape Reporting Units of 5th-level 10-digit hydrologic units (for aquatic resources) and a grain size of 30m pixel grids (for terrestrial resources & vegetation). Our intention is to utilize reporting units and metrics at the finest extent and grain supported by the source data so, for example, a "where is it?" MQ will be answered using the source data resolution (e.g., 30 m to depict CE distribution or areas of CEs intersecting CAs).

A generalized assessment workflow is provided in **Error! Reference source not found.**; detailed assessment (model) workflows were provided in Memorandum 3c. Process workflow for Task 6 is diagrammed in Figure 5. The remainder of this section of the workplan organizes the assessment tasks and provides supporting detail for the MQ table (Appendix I). As described in Memorandum 3c and further illustrated here, we are utilizing a scenario-based approach to answer MQs relevant to different timeframes requested in the REA SOW:

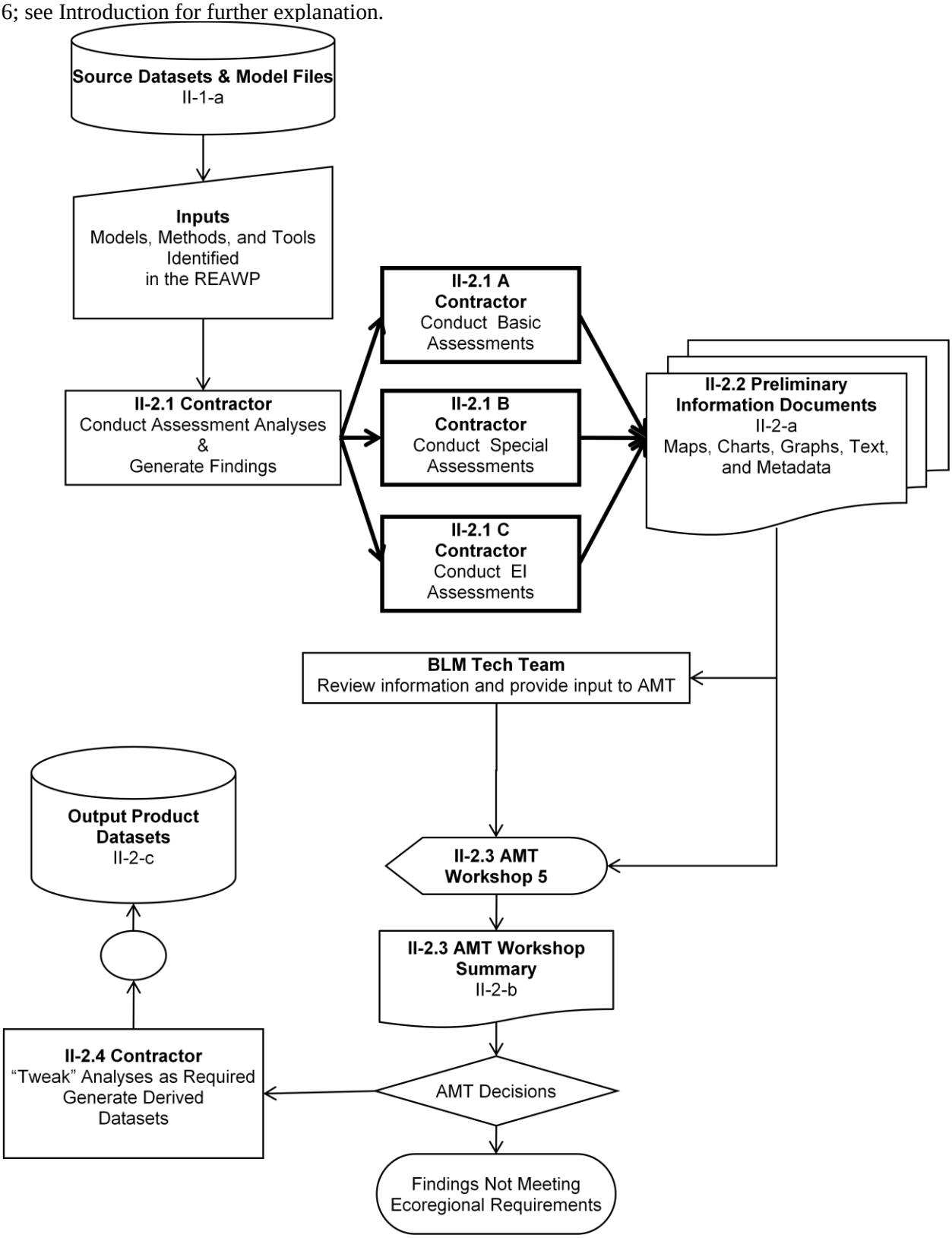
- Current: represented by mapped CAs or those for which we can model their distribution as of May, 2011.
- 2025: includes all current CAs and those forecast to occur by 2025.
- 2060: includes all of the above CA distributions plus climate change forecasts for 2060.

While several MQs are interested in individual CAs or groups of CAs, the scenario approach also supports a cumulative effects assessment of the interaction of all identified CAs. The aggregation of CAs in scenarios supports results for multiple MQ, from basic questions about interactions among CAs and CAs with CEs, to modeling the CE ecological integrity ramifications of the different scenarios.

Figure 4. Scenario-based assessment workflow.

Figure 5. Process workflow for Task 6.

The original numbering of the Phase II tasks is followed in this diagram. II-1 = Task 5; II-2 = Task 6; see Introduction for further explanation.



Assessments

Our assessment is organized according to the features depicted in **Error! Reference source not found.**:

- Where are CEs and CAs: These MQs are addressed with basic assessments conducted using the source data or generated distributions from Task 5.
- What is the current condition of the CEs: These MQs also are addressed with basic assessments conducted using the source data or generated distributions from Task 5.
- Where do CAs intersect CEs based on the three different time scenarios generated from the CAs for current, 2025, and 2060 timeframes.
- Relative effects of CAs on CEs as a factor of applying landscape condition models for the different scenarios. We further break this down into special assessments for the more complex MQs.

Where are CEs and CAs?

This assessment was described in Memorandum 3c and simply asks for maps of the locations of each CE and CA. In this assessment category we include all MQs of this type, such as "Where are high biodiversity sites." This data will be gathered or generated in Task 5. To complete the assessment we will create the standard map outputs and generate spatial statistics on the mapped area of each feature.

Applicable scenarios: current for CEs and all scenarios for CAs but see specific MQs.

Inputs: Distribution maps for CEs and CAs

Analytical process: Spatial statistics calculations

Outputs: Map of each CE and CA distribution and statistic of the area of each CE and CA

Anticipated timeline: May-July, 2011

Issues and limitations: Same as for the input data

Where do CAs Intersect CEs?

After generation of CAs and their aggregation the respective scenarios, we will conduct the intersection of CAs and CEs to answer specific MQ requesting this information.

Applicable scenarios: current, 2025 and 2060 scenarios, refer to individual MQs

Inputs: Distribution maps for CEs and CAs

Analytical process: GIS intersect of select CEs and CAs as specified by the relevant MQs.

Outputs: Map of each CE distribution with areas of CA intersect indicated with a separate value for the overlapping CA or "multiple" for >1 CA. Statistics on the area and proportion of the CE overlapped by each CA and total area and proportion of the CE overlapping with all specified CAs.

Anticipated timeline: June- September, 2011

Issues and limitations: Same as the input data

What is the Current Condition of CEs?

This assessment was described in Memorandum 3c and involves the generation of ecological integrity assessment (EIA) scores for the status of each terrestrial and aquatic CE based on Key Ecological Attributes (KEA) and associated indicators. This assessment category includes all MQs that focus on the current condition of CEs. This assessment category addresses all MQs that focus on specific stressors (e.g., water use) affecting the CE (e.g., "What is the present distribution of municipal and agricultural water use of groundwater resources?"). The data will be gathered or generated in Task 5. To complete the assessment we will generate assessment results for each indicator, for each KEA, by reporting unit, and "roll up" these KEA-level results into a CE score by reporting unit. Memorandum 3c presents the methodology and an example.

Applicable scenarios: all CEs, but see specific MQs.

Inputs: Data on multiple indicators, as established in the EIA model for each CE type (see Memorandum 3c)

Analytical process: The analytical process differs for each indicator type, but all analyses generate output structured according to the same scorecard framework, as described in Memorandum 3c.

Outputs: Map of EIA scores for each CE by Reporting Unit

Anticipated timeline: June-September, 2011

Issues and limitations: Same as for the input data

Ecological Integrity Assessment Roll-up for the Ecoregion

BLM REA guidance for ecological integrity assessment (EIA) calls for a roll-up across all CEs for the ecoregion although there is no explicit MQ addressing this assessment. We propose to conduct this roll-up and report summary statistics for the **current conditions** for each 5th level HUC; however, additional discussion on this topic is ongoing.

Scenario-Based Assessments

As described above and in Memorandum 3c, many assessments are based on scenarios that are aggregations of mapped or forecast CA distribution for the scenario year. Here we provide further details for the generation and content of each scenario and the assessments based on these scenarios. As soon as Task 5 data gathering and generation are complete, we will begin the scenario generation. For MQs that address individual classes or types of CAs, we will extract those CAs as specified in the MQ.

Scenario Generation

Current Scenario

The current land use scenario will comprise all mapped or modeled CAs representing the current extent of these CAs as of 2011.

Inputs: The inputs are detailed in Table 8. This list does not include surface and groundwater use; these two change agents are addressed through the indicators for the impacts of surface water use and groundwater use incorporated into the aquatic coarse-filter ecological integrity assessment scorecard for each aquatic CE.

Table 8. Current Scenario Inputs

Input	Type	Source
Urbanization	Existing data*	ICLUS/SERGoM
Roads	Existing data*	BLM Linear Infrastructure
Pipelines	Existing data*	BLM Linear Infrastructure, National Pipeline Mapping System
Transmission lines	Existing data*	BLM Linear Infrastructure
Water transmission	Existing data*	USGS NHD plus
Railroads	Existing data*	National Transportation Atlas Database
Renewable Energy Solar	Existing data*	All existing and approved (as of 05/01/2011) solar projects on federal land (e.g. Solar Energy PEIS)
Renewable Energy Wind	Existing data*	All existing and approved (as of 05/01/2011) wind projects on federal land (e.g. Wind Energy PEIS)
Renewable Energy Geothermal	Existing data*	All operating geothermal plants (Great Basin Center for Geothermal Energy)
Extractive Energy Oil & Gas	Existing data*	Detailed oil and gas well locations; this geodatabase was compiled by the BLM from western state government agencies in December, 2010

Input	Type	Source
Mines and Landfills	Model**	This development CA will be modeled by the NatureServe team
Military Urbanized Areas	Existing data*	Urban areas on military reservations will be taken from the NatureServe ecological systems of the US land cover map
Crops, Orchards & Irrigated Pastures	Existing data*	NatureServe ecological systems of the US land cover map
Recreation	Model**	NatureServe will develop this model for the current scenario (See Memorandum 3c, Figure 23)
Invasive species	Model**	NatureServe will develop this model for the current scenario, see Terrestrial Invasive CAs models (Memorandum 3c, Figure 8)

*See Memorandum 2c for more information.

**See Memorandum 3c for more information.

Analytical process: Most of the development features in the current land use scenario are derived from existing data sources. These data will be assembled and organized according to the BLM data management protocol. They will reclassified under a unified land cover class system and rasterized to form a unified map suitable for use in the landscape condition model described later.

Outputs: Current scenario land use map at 90m resolution; Land use map (without recreation) will achieve a 30m resolution; Aquatic invasives will be summarized to 5th level HUC

Anticipated timeline: June-July 2011

Issues and limitations: The scenario is derived mostly from third-party sources and represents a range of data resolutions, currency, and accuracy.

2025 Scenario

The 2025 scenario will include all the change agents from the current scenario plus those changes forecast to occur by 2025.

Inputs: The inputs are detailed in Table 9.

Table 9. 2025 Scenario Inputs

Input	Type	Source
Urbanization	Existing data*	2025 projections from ICLUS/SERGoM (see Memorandum 2c)
Roads	Existing data*	No change from current scenario
Pipelines	Existing data*	No changes except for the addition of the Ruby Pipeline in CBR
Transmission lines	Existing data*	Will include Section 368 West-wide Energy Corridor Programmatic EIS and California RETI planned transmission line expansions
Water transmission	Existing data*	No change from current scenario
Railroads	Existing data*	No change from current scenario
Renewable Energy Solar	Existing data*	Proposed/in-review solar projects on federal land in review by the BLM as of 05/01/2011.
Renewable Energy Wind	Existing data*	Proposed/in-review wind projects on federal land by the BLM as of 05/01/2011
Renewable Energy Geothermal	Existing data*	Proposed/in-review geothermal projects on federal land in review by the BLM as of 05/01/2011

Input	Type	Source
Extractive Energy Oil & Gas	Existing data*	No change from current scenario
Mines and Landfills	Model**	No change from current scenario
Military Urbanized Areas	Existing data*	No change from current scenario
Crops, Orchards & Irrigated Pastures	Existing data*	No change from current scenario
Recreation	Model**	No change from current scenario
Invasive Species	Model**	NatureServe will develop terrestrial models for 2025, see Terrestrial Invasive CAs models (Memorandum 3c, Figure 8);

*See Memorandum 2c for more information

**See Memorandum 3c for more information

Analytical process: These data will be assembled and organized according to the BLM data management protocol. They will be reclassified under a unified land cover class system and rasterized to form a unified map.

Outputs: 2025 scenario land use map at 90m resolution; Land use map (without recreation) will achieve a 30m resolution; Aquatic invasives will be summarized to 5th level HUC

Anticipated timeline: June-July 2011

Issues and limitations: Datasets such as ICLUS/SERGoM are based on best available knowledge and understanding of spatial patterns of development. However, the spatial extent and location of development projects will change as practices and policies change over time. This is especially true for transmission corridor and energy projects. We also expect that projects identified by their lease areas will significantly over-estimate the actual project footprint by assuming that entire lease area will be developed which in reality is unlikely. While the future footprint is overestimated, some components of the energy project may not be included such as roads and transmission lines that will connect the project with the respective network unless data is forthcoming. This future scenario does not assume any restoration of existing impacts (e.g., mine or road restoration that may return some ecological function to an area). The most significant absence in the future scenario will be existing and future private/state land development which is not centrally tracked and therefore not practically included.

2060 Scenario

The 2060 land use scenario will include all the change agents from the 2025 scenario, terrestrial invasives vulnerability, and urban growth modeled to the year 2060, plus interpretations of modeled climate change effects.

Inputs: See Table 10 below for inputs to this scenario.

Table 10. 2060 Scenario Inputs

Input	Type	Source
Urbanization	Existing data	2060 projections from ICLUS/SERGoM (see Memorandum 2c)
Roads	Existing data	No change from current scenario
Pipelines	Existing data	No change from 2025 scenario
Transmission lines	Existing data	No change from 2025 scenario
Water transmission	Existing data	No change from current scenario
Railroads	Existing data	No change from current scenario
Renewable Energy Solar	Existing data	No change from 2025 scenario

Renewable Energy Wind	Existing data	No change from 2025 scenario
Renewable Energy Geothermal	Existing data	No change from 2025 scenario
Extractive Energy Oil & Gas	Existing data	No change from current scenario
Mines and Landfills	Model	No change from current scenario
Military Use Areas	Existing data	No change from current scenario
Crops, Orchards & Irrigated Pastures	Existing data	No change from current scenario
Recreation	Model	No change from current scenario
Invasive species	Model	NatureServe will develop these models for 2060, see Terrestrial Invasive CAs models (Memorandum 3c, Figure 8)
Climate change	Model	NatureServe/California Academy of Sciences will create this model for 2060, see Climate Change Effects models (Memorandum 3c, Task 5 work above, and description below)

Analytical process: These data will be assembled and organized according to the BLM data management protocol. They will be reclassified under a unified land cover class system and rasterized to form a unified map. Given uncertainties in spatial forecasts, much of this scenario assessment will consist of interpretations of the generalized map outputs.

Outputs: 2060 scenario at 4km resolution

Anticipated timeline: July-August, 2011

Issues and limitations: See previous discussion of climate change effects and invasive species models for clarification on data limitations. These limitations preclude detailed spatial/analytical results comparable to other scenarios. Expert interpretation of broad trends identified through this spatial analysis will form the basis for this assessment.

Climate Change Effects

Climate change effects represent the other major group of MQs dealing with relative effects of CAs on CEs. The climate change MQs can be categorized into the following groups:

- Which areas/units/features will experience significant climate change. We propose to characterize measurably "significant" change as 1 and/or 2 standard deviations from baseline mean values for key climate variables. These thresholds do not imply ecological substantive change, which will require extensive research to determine. Instead, they will be used here as a trigger to suggest where new research might concentrate in order to address management questions.
- Where will potential for other CAs increase due to climate change, e.g., where might fire risk increase (such as where climate and increased invasives may increase fire frequency).
- How might selected terrestrial CE distributions change with climate change, e.g., where might CE's habitats experience increased fragmentation through a probable loss in extent over large areas. (Note that potential changes in distribution cannot be assessed for aquatic CEs, as indicated above).

Applicable scenarios: 2060

Inputs: climate change data, CE and CA distributions

Analytical process: These assessments begin with the climate change effects models. Many MQs can then be answered directly by intersecting the features with the climate change effects data; or through interpretation of broad patterns resulting from those analyses. Some will require secondary modeling of

changes to CAs and then how those changed CAs will affect the CEs. Additional details were provided in Memorandum 3c.

Outputs: see specific MQs

Anticipated timeline: May-September, 2011

Issues: as described in Memorandum 3c.

Special Assessments

Special assessments were identified and described in detail in Memorandum 3c. These assessments do not fall within the basic assessments described above but most utilize some or all of the basic assessments.

Restoration

In Memorandum 3c, we outlined our modeling approach for three restoration models: general landscape restoration opportunities, linear connectivity restoration, and 2010 invasives restoration opportunities. This work item will occur later in Task 6 as the inputs are the outputs of multiple processes.

Applicable scenarios: Management focus is on areas currently needing restoration but the 2025 and 2060 scenarios will also be utilized to understand where restoration may still be viable for longer timeframes under additional CA effects in the future.

Inputs: Current scenario CE condition-based assessment models; 2025 scenario CE condition-based assessment models; Focal landscape species critical habitat areas; Existing wildlife corridors to be obtained from state wildlife agencies (where applicable); Modeled wildlife corridors; Current scenario CEs significantly affected by invasives.

Analytical process: see details in Memorandum 3c

Outputs: Map of General Restoration Opportunities; Map of Connectivity Restoration Opportunities; Map of Current Invasives Restoration Opportunities

Anticipated timeline: August-September, 2011

Issues and limitations: These assessment opportunities present a very broad brush of restoration opportunities. Species or ecological system specific restoration sites will need to be evaluated with more specific models that include additional environmental variables and finally evaluated in the field. In addition, wildlife corridor maps and models are very incomplete throughout the west and many modeled corridors have not been validated rigorously. These models may best serve as initial opportunities flagging tool and do not intend to be a substitute for site analysis and more rigorous modeling. Please see details in Memorandum 3c.

Grazing Allotments (GAs) and Herd Management Areas (HMAs)

As described in Memorandum 3c, GAs and HMAs are used as reporting units.

Applicable scenarios: all, see specific MQs

Inputs: GA and HMA boundaries, climate change assessment results, CE EIA for each scenario

Analytical process: depending on MQ, the results for the climate and CE inputs noted above will be attributed to each GA and HMA.

Outputs: climate change statistics and CE EIA metrics for each GA and HMA.

Anticipated timeline: August-September, 2011

Issues and limitations: As noted in Memorandum 3c, we anticipate the need for further targeted discussion with the AMT on the metrics for these assessments.

Energy Development Assessment

The energy development assessments were detailed extensively in Memorandum 3c and span a wide range of complexity from very simple "where is it" questions to those requiring integration of results from multiple models.

Applicable scenarios: all, see specific MQs

Inputs: existing renewable and non-renewable energy development, new projects in the approval pipeline, and areas with high potential for development; hydrological assessment results; existing and forecast CAs, CE distributions; high biodiversity sites; summary ecological integrity assessment outputs.

Analytical process: see details in Memorandum 3c.

Outputs: see specific energy MQs in Appendix I.

Anticipated timeline: July-September, 2011

Issues and limitations: See details in Memorandum 3c and specifically resolution of whether the Areas of Potential Mitigation for future energy development assessment should be conducted and if so to what level of optional detail we proposed.

Generate draft REA products for workshop review

We will build an extensive PowerPoint slide library and presentation for the AMT workshop 5 that depicts all deliverables in draft form and where applicable provide for live demonstration of databases and GIS projects.

Conduct AMT workshop 5 to review products and submit workshop summary

This workshop will review all of the draft products generated during this task to identify needed changes to any part of the process (e.g., workflow, models, data inputs) prior to finalizing the assessment.

Revise process and products and deliver draft datasets for BLM review

All assembled data will be assimilated within the context of an ESRI Versioned Geodatabase (or as specified by BLM) for review.

Task 6 Deliverables

- Preliminary Information Documents (II-2-a):
  - While a memorandum is not required for Phase II tasks, we will produce draft narrative content for the final REA Report covering Tasks 5 and 6 components such as methods and limitations. We will provide this to the AMT for review if desired prior to incorporation in the REA Report in Task 7.
  - Draft assessment products including maps and reporting metrics for each MQ.
- AMT Workshop 5: This is a critical workshop where the initial results of the assessment are presented for the AMT. Agenda will be developed approximately 4-6 weeks in advance and at that time we will determine (with the AMT lead) if we will conduct a 2 or 3-day workshop.
- Workshop Summary (II-2-b): We will prepare and submit a workshop summary, which includes AMT guidance provided at the workshop for any agreed changes to the work products.
- Draft Status, Attribute, Indicator, and Potential for Change Datasets (II-2-c): We will deliver draft datasets for BLM review of data adequacy.

Task 6 Schedule

The basic assessments for Task 6 (the *where are they* MQs) will be conducted in parallel with Task 5 as the data are produced.

Table 11. Summary schedule for Task 6

Item	Date
Draft REA documents will be completed and delivered	Sept 3, 2011
BLM Review of documents	Sept 13, 2011
AMT Workshop 5	Sept 15, 2011
Workshop Summary	Sept 20, 2011

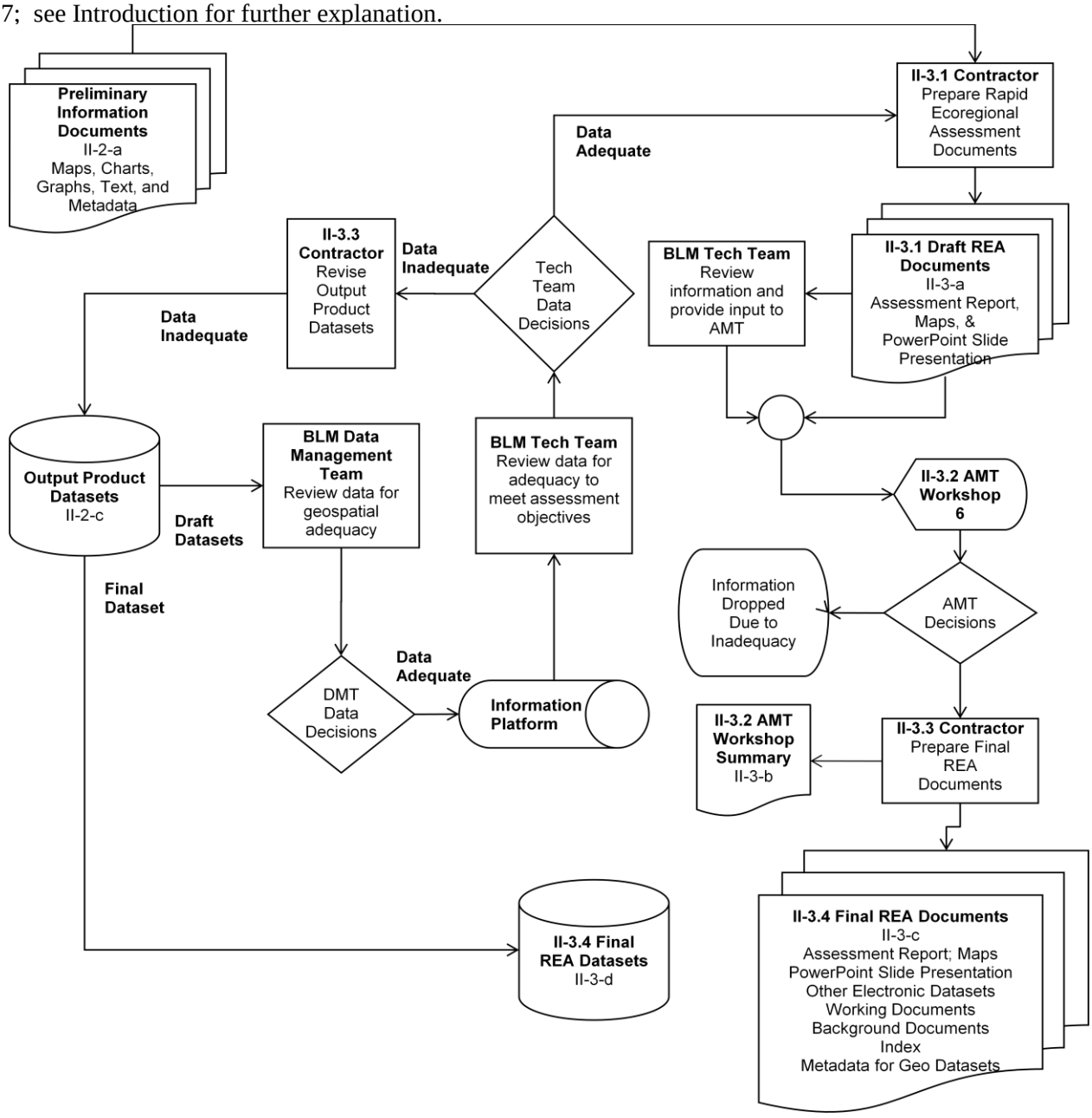
AMT final comments due	Sept 22, 2011
Revised Products	Oct 23, 2011
BLM Approval	Oct 28, 2011

Task 7: Prepare Rapid Ecoregional Assessment Documents

The objective of this task is to consolidate the information and findings from the REA into several products. The REA will be summarized in several work product documents including a Rapid Ecoregional Assessment Report, a PowerPoint presentation, and maps suitable for wall mounting. Much of this information will have been developed and written as memoranda and associated work product documents during prior Phase I and Phase II tasks with this task being conducted to compile that information into the assessment's final deliverables. NatureServe will prepare both draft and final versions of these primary REA documents. The draft documents will be presented at an AMT workshop in order to describe the products and receive feedback and direction prior to preparation of the final work product documents. The process work flow for this Task is shown in Figure 6. In addition the task includes compiling, documenting and delivering many ancillary documents acquired or developed during the REA.

Figure 6. Task 7 process workflow.

The original numbering of the Phase II tasks is followed in this diagram. II-2 = Task 6; II-3 = Task 7; see Introduction for further explanation.



Develop draft REA documents and deliver to AMT

We will assemble a complete set of deliverables and submit them to the AMT for initial review prior to the workshop. Deliverables include:

- Draft Ecoregional Assessment Report
- Draft ARCH size D or larger maps for presentation use (because the REA will generate hundreds of digital maps we will only print those identified by BLM for this purpose)
- Draft PowerPoint "slide-library" presentation.

At a minimum, the following information will be included in the REA Report:

- Executive Summary
- Introduction, including description of the ecoregional assessment process
- Ecoregional resource concerns and management questions
- Brief summary of the methodologies used in the investigation
- Summary of ecoregion conditions regarding conservation elements and change agents
- Results and findings of output products regarding status and potential for change
- Specific answers to management questions
- A description of how this information may be used in planning for land use, developing best management practices, authorizing uses, and establishing conservation and restoration priorities
- Lessons learned from the REA, and what next steps could be taken
- Appendices describing datasets, tools, models, and processes used for the assessment.

Other documents we will prepare include maps to depict the current status of the assessed conservation elements, change agents, and for status integrated to the watershed level or provided in a regular 30-meter grid. Individual maps as identified by BLM will be included in the REA report (11 x 17 format), and also provided in formats suitable for wall map (e.g., ARCH size D or larger), and as PowerPoint slide(s).

A PowerPoint presentation will be developed that presents the report information summarized in the above bullet points. This "slide library" will build on those developed for earlier Phase I and Phase II tasks, and will provide a complete description of the ecoregional assessment process and findings (including select maps).

Conduct AMT Workshop 6 and deliver a summary for BLM review

Per agreement with BLM, this workshop will be conducted as a webinar after sufficient review time for the AMT. All of the essential content will have been reviewed in AMT 5, therefore a webinar should be sufficient to identify final revision needs. We will focus the webinar on discussion of items that received significant and or contradictory review by the AMT. We will prepare a summary of the webinar documenting guidance we receive from the AMT and required revisions to the draft products.

Revise deliverables according to comments received from AMT for final review

Revisions will be conducted promptly and will be resubmitted for review. These may include revisions to documents, as well as to data products, as they are reviewed by BLM.

Develop final versions of products and submit for BLM acceptance

Based on the above review, we will conduct any additional necessary revisions and submit all deliverables for final acceptance.

List of Final Deliverables

- Final REA Documents (II-3-c): to be submitted for final BLM review
  - Final Ecoregional Assessment Report
  - Final ARCH size D or larger maps for presentation use
  - Final PowerPoint "slide-library" presentation.
- Other Electronic Datasets (II-3-c): Other electronic data or datasets collected or generated by NatureServe.
- Documentation (II-3-c):
  - We will provide step-by-step methods documentation that includes references to the submitted model builder and other tool application steps that were used for data processing. These

documented methods will be routinely updated throughout the project to account for changes and improvements made along the way.
    - Notes and Working Documents: Workshop summaries and other notes taken from communications with BLM and within the team will also be documented and linked to tasks.
    - Background Documents and Index (II-3-c): NatureServe will provide all documents (e.g., agency reports, maps) collected by NatureServe during the course of the project that are used to support the REA. The documents will be provided in suitable binding, boxed collections, and digital media per guidance provided by BLM and the volume will be referenced to the steps of the process.
- Final REA Datasets (II-3-d): NatureServe will provide the final collected, compiled, and generated CE & CA datasets; final output status and potential for change datasets in a form acceptable to BLM.

Task 7 Schedule

We have proposed a variation from the original schedule but maintain the original final completion date. Because of coincidence with the end of year holidays, adjustments were required to allow sufficient time for document development and AMT review.

Table 12. Summary schedule for Task 7

Item	Date
Draft REA documents will be completed and delivered	11/23/11
AMT Workshop 6 (webinar)	12/5/11
Workshop Summary	12/9/11
AMT final comments due	12/16/11
Revised Products	1/6/12
BLM review	1/20/12
Final products	1/31/12
BLM final review	2/10/12

Glossary

Areas of Critical Environmental Concern (ACEC): Areas within the public lands where special management attention is required to protect and prevent irreparable damage to important historic, cultural, or scenic values, fish and wildlife resources or other natural systems or processes, or to protect life and safety from natural hazards. (FLPMA, 1976).

Assessment Management Team (AMT): BLM's team that provides overall direction and guidance to the REA and makes decisions regarding ecoregional goals, resources of concern, conservation elements, change agents, management questions, tools, methodologies, models, and output work products. The team generally consists of State Resources Branch Managers from the ecoregion, a POC, and possibly agency partners.

Attribute: A defined characteristic of a geographic feature or entity.

Change Agent: An environmental phenomenon or human activity that can alter/influence the future status of resource condition. Some change agents (e.g., roads) are the result of direct human actions or influence. Others (e.g., climate change, wildland fire, invasive species) may involve natural phenomena or be partially or indirectly related to human activities.

Coarse Filter: A focus of ecoregional analysis that is based upon conserving resource elements that occur at coarse scales, such as ecosystems, rather than upon finer scale elements, such as specific species. The concept behind a coarse filter approach is that preserving coarse-scale conservation elements will preserve elements occurring at finer spatial scales.

Community: Interacting assemblage of species that co-occur with some degree of predictability and consistency.

Conservation Element: A renewable resource object of high conservation interest often called a conservation target by others. For purposes of this TO, conservation elements will likely be types or categories of areas and/or resources including ecological communities or larger ecological assemblages.

Development: A type of change (change agent) resulting from urbanization, industrialization, transportation, mineral extraction, water development, or other non-agricultural/silvicultural human activities that occupy or fragment the landscape or that develops renewable or non-renewable resources.

Didymo: *Didymosphenia geminate*, a species of diatom considered to be a nuisance species

Ecological Integrity: The ability of an ecological system to support and maintain a community of organisms that have the species composition, diversity, and functional organization comparable to those of natural habitats within the ecoregion.

Ecoregion: An ecological region or ecoregion is defined as an area with relative homogeneity in ecosystems. Ecoregions depict areas within which the mosaic of ecosystem components (biotic and abiotic as well as terrestrial and aquatic) differs from those of adjacent regions. (Omernik and Bailey, 1997).

Ecosystem: The interactions of communities of native fish, wildlife, and plants with the abiotic or physical environment.

Element Occurrence: A term used by Natural Heritage Programs. An element occurrence generally delineates the location and extent of a species population or ecological community stand, and represents the geo-referenced biological feature that is of conservation or management interest. Element occurrences are documented by voucher specimens (where appropriate) or other forms of observations. A single element occurrence may be documented by multiple specimens or observations taken from different parts of the same population, or from the same population over multiple years.

Extent: The total area under consideration for an ecoregional assessment. For the BLM, this is a CEC Level III ecoregion or combination of several such ecoregions plus the buffer area surrounding the ecoregion. See *grain*.

Fine Filter: A focus of ecoregional analyses that is based upon conserving resource elements that occur at fine scale, such as specific species. A fine-filter approach is often used in conjunction with a

coarse-filter approach (i.e., a coarse-filter/fine-filter framework) because coarse filters do not always capture some concerns, such as when a T&E species is a conservation element.

Fire Regime: Description of the patterns of fire occurrences, frequency, size, severity, and sometimes vegetation and fire effects as well, in a given area or ecosystem. A fire regime is a generalization based on fire histories at individual sites. Fire regimes can often be described as cycles because some parts of the histories usually get repeated, and the repetitions can be counted and measured, such as fire return interval (NWCG, 2006).

Fragmentation: The process of dividing habitats into smaller and smaller units until their utility as habitat is lost (USDI, BLM, 1997).

Geographic Information System (GIS): A computer system designed to collect, manage, manipulate, analyze, and display spatially referenced data and associated attributes.

Grain: Grain is the spatial unit of analysis for ecoregional assessment and is the smallest area analyzed and used for regional planning purposes. The many data and model outputs incorporated into an ecoregional analysis are usually upscaled or downscaled to grain scale. The grain for ecoregional analysis may be a regular size and shape (e.g., square, hexagon) but also may be defined by a particular level of hydrologic unit or similar geographic feature.

Habitat: A place where an animal or plant normally lives for a substantial part of its life, often characterized by dominant plant forms and/or physical characteristics (USDI, BLM, 1990).

Heritage: See *Natural Heritage Program.*

Heritage Program: See *Natural Heritage Program.*

Hydrologic Unit: An identified area of surface drainage within the U.S. system for cataloging drainage areas, which was developed in the mid-1970s under the sponsorship of the Water Resources Council and includes drainage-basin boundaries, codes, and names. The drainage areas are delineated to nest in a multilevel, hierarchical arrangement. The hydrologic unit hierarchical system has four levels and is the theoretical basis for further subdivisions that form the *watershed boundary dataset* 5th and 6th levels. (USDI, USGS, 2009).

Indicator: Components of a system whose characteristics (e.g., presence or absence, quantity, distribution) are used as an index of an attribute (e.g. land health) that are too difficult, inconvenient, or expensive to measure. (USDA et al, 2005).

Invasive Species: Species that are not part of (if exotic non-natives), or are a minor component of (if native), an original community that have the potential to become a dominant or co-dominant species if their future establishment and growth are not actively controlled by management interventions, or that are classified as exotic or noxious under state or federal law. Species that become dominant for only one to several years (e.g. short-term response to drought or wildfire) are not invasives (Modified from BLM Handbook 1740-2, Integrated Vegetation Handbook).

Key Ecological Attribute: An attribute, feature, or process that defines and characterizes an ecological community or system or entity; in conjunction with other key ecological attributes, the condition or function of this attribute or process is considered critical to the integrity of the ecological community or system in question. In the BLM REAs, various analyses will be conducted to calculate scores or indexes indicating the status of key ecological attributes for various Conservation Elements (CEs).

Landscape Species: Biological species that use large, ecologically diverse areas and often have significant impacts on the structure and function of natural ecosystems (Redford et al., 2000).

Landscape Unit: Because an REA considers a variety of phenomena, there will be many phenomena and process (or intrinsic) grain sizes. These will necessarily be scaled to a uniform support unit, which herein is called a *landscape unit*. This landscape unit will be the analysis scale used for reporting and displaying ecoregional analyses.

Management Questions: Questions from decision-makers that usually identify problems and request how to fix or solve those problems.

Metadata: The description and documentation of the content, quality, condition, and other characteristics of geospatial data.

Model: Any representation, whether verbal, diagrammatic, or mathematical, of an object or phenomenon. Natural resource models typically characterize resource systems in terms of their status and change through time. Models imbed hypotheses about resource structures and functions, and they generate predictions about the effects of management actions. (Adaptive Management: DOI Technical Guide).

Native Plant and Animal Populations and Communities: Populations and communities of all species of plants and animals naturally occurring, other than as a result of an introduction, either presently or historically in an ecosystem. (BLM Manual H-4180-1).

Native Species: Species that historically occurred or currently occur in a particular ecosystem and were not introduced (USDI, BLM, 2007b).

Natural Community: An assemblage of organisms indigenous to an area that is characterized by distinct combinations of species occupying a common ecological zone and interacting with one another (USDI, BLM, 2007b).

Natural Heritage Program: An agency or organization, usually based within a state or provincial natural resource agency, whose mission is to collect, document, and analyze data on the location and condition of biological and other natural features (such as geologic or aquatic features) of the state or province. These programs typically have particular responsibility for documenting at-risk species and threatened ecosystems. (See natureserve.org/ for additional information on these programs.)

Occurrence: See *Element Occurrence*.

Population: Individuals of the same species that live, interact, and migrate through the same niche and habitat.

Rapid Ecoregional Assessment (REA): The methodology used by the BLM to assemble and synthesize that regional-scale resource information, which provides the fundamental knowledge base for devising regional resource goals, priorities, and focal areas, on a relatively short time frame (less than 2 years).

Rapid Ecoregional Assessment Work Plan (REAWP): The work plan (scope of services) that guides the Phase II Assessment component of a REA. This document fully establishes the design of the Phase II effort, and is essentially the 'blueprint' for that work effort and resulting products.

Resource Value: An ecological value, as opposed to a cultural value. Examples of resource values are those species, habitats, communities, features, functions, or services associated with areas with abundant native species and few non-natives, having intact, connected habitats, and that help maintain landscape hydrologic function. Resource values of concern to the BLM can be classified into three categories: native fish, wildlife, or plants of conservation concern; regionally-important terrestrial ecological features, functions, and services; and regionally-important aquatic ecological features, functions, and services.

Scale: Refers to the characteristic time or length of a process, observation, model, or analysis. ***Intrinsic scale*** refers to the scale at which a pattern or process actually operates. Because nature phenomena range over at least nine orders of magnitude, the intrinsic scale has wide variation. This is significant for ecoregional assessment, where multiple resources and their phenomena are being assessed. ***Observation scale***, often referred to as sampling or measurement scale, is the scale at which sampling is undertaken. Note that once data are observed at a particular scale, that scale becomes the limit of analysis, not the phenomenon scale. ***Analysis*** or ***modeling scale*** refers to the resolution and extent in space and time of statistical analyses or simulation modeling. ***Policy scale*** is the scale at which policies are implemented and is influenced by social, political, and economic policies.

Scaling: The transfer of information across spatial scales. ***Upscaling*** is the process of transferring information from a smaller to a larger scale. ***Downscaling*** is the process of transferring information to a smaller scale.

Status: The condition of a criterion (biological or socio-economic resource values or conditions) within a geographic area (e.g., watershed, grid). A rating (e.g., low, medium, or high) or ranking (numeric) is assigned to specific criteria to describe status. The rating or ranking will be relative, either to the historical range of variability for that criterion (e.g., a wildland fire regime criterion) or relative to a time period when the criterion did not exist (e.g., an external partnerships/collaboration criterion).

Stressor: A factor causing negative impacts to the biological health or ecological integrity of a Conservation Element. Factors causing such impacts may or may not have anthropogenic origins. In the context of the REAs, these factors are generally anthropogenic in origin.

Subwatershed: A subdivision of a *watershed*. A *subwatershed* is the 6th-level, 12-digit unit and smallest of the hydrologic unit hierarchy. Subwatersheds generally range in size from 10,000 to 40,000 acres. (USDI, USGS, 2009).

Value: See *resource value*.

Watershed: A watershed is the 5th-level, 10-digit unit of the hydrologic unit hierarchy. Watersheds range in size from 40,000 to 250,000 acres. Also used as a generic term representing a drainage basin or combination of hydrologic units of any size. (USDI, USGS, 2009).

Watershed Boundary Dataset (WBD): A National geospatial database of drainage areas consisting of the 1st through 6th hierarchical hydrologic unit levels. The WBD is an ongoing multiagency effort to create hierarchical, and integrated hydrologic units across the Nation. (USDI, USGS, 2009).

Wildland Fire: Any non-structure fire that occurs in the wildland. Three distinct types of wildland fire have been defined and include wildfire, wildland fire use, and prescribed fire (NWCG, 2006).

List of Acronyms

AADT	Annual Average Daily Traffic
ACEC	Area of Critical Environmental Concern
AFB	Air Force Base
AGI	Annual Grasses Index
AML	appropriate management level
AMT	Assessment Management Team
AR4	Intergovernmental Panel on Climate Change - Fourth Assessment Report
ARRA	American Recovery and Reinvestment Act
AUC	Area Under the (ROC) Curve
AUM	Animal Unit Month
AWC	Available Water Capacity
AWS	Associate Weather Services
BCM	Basin Characterization Model
BLM	Bureau of Land Management
BpS	Biophysical Settings
CA	Change Agent
CA ReGAP	California Regional Gap Analysis Project
CA GAP	California Gap Analysis Project
CART	classification and regression tree
CBR	Central Basin and Range
CCVI	Climate Change Vulnerability Index
CD	compact disc
CE	Conservation Element
CEC	Commission for Environmental Cooperation
CO	contracting officer
COR	contracting officer's representative
CVS	Conservation Value Summary
DDTF	Data Delivery Tracking Form
DEM	Digital Elevation Model
DMP	data management plan
DOD	Department of Defense
DOE	Department of Energy
DOI	Department of Interior
DQE	Data Quality Evaluation
DRI	Desert Research Institute
DRS	Division of Resource Services
DSS	Decision Support System
DVD	Digital Versatile Disc
EFC	Environmental Flow Components
EIA	Ecological Integrity Assessment
EIS	Environmental Impact Statement
EO	Element Occurrence

EPA	Environmental Protection Agency
EPCA	Energy Policy and Conservation Act
ERA	ecoregional assessment
ESA	Endangered Species Act
ESD	Ecological Site Description
ESRI®	Environmental Systems Research Institute, Inc.
ET	evapotranspiration
EVT	Existing Vegetation Type
FAO	Food and Agriculture Organization
FCC	Federal Communications Commission
FGDC	Federal Geographic Data Committee
FLPMA	Federal Land Policy and Management Act
FO	Field Office
FRCC	Fire Regime Condition Class
FRI	Fire Return Interval
FTP	File Transfer Protocol
GA	Grazing Allotment
GAP	Gap Analysis Project
GBPJW	Great Basin Pinyon-Juniper Woodland
GCM	General Circulation Model
GFDL	Geophysical Fluid Dynamics Laboratory
GFF	government-furnished facilities
GFM	government-furnished material
GFP	government-furnished property
GIS	Geographic Information System
HA	Herd Area
HMA	Herd Management Area
HRV	Historic Range of Variation
HU	hydrologic unit
HUC	hydrologic unit code
IBA	Important Bird Areas
ICLUS	Integrated Climate and Land Use Scenarios
IDIQ	indefinite delivery/indefinite quantity
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
JPEG	Joint Photographic Experts Group
Kw	K factor (soil erodibility)
LANDFIRE	Landscape Fire and Resource Management Planning Tools Project
LCM	Landscape Condition Model
LF	LANDFIRE
LFRDB	LANDFIRE Reference Database
LRU	landscape reporting unit
LU/LC	land use/land cover
LUP	Land Use Plan

MaxEnt	Maximum Entropy (modeling software)
MBR	Mojave Basin and Range
MRLA	Multiple Resource Land Area
MQ	Management Question
MRDS	USGS Mineral Resource Data System
NADP	National Atmospheric Deposition Program
NAS	USGS Nonindigenous Aquatic Species
NCAR	National Center for Atmospheric Research
NCEP	National Centers for Environmental Prediction
NED	National Elevation Dataset
NEPA	National Environmental Policy Act
NGO	non-governmental organization
NHD	National Hydrography Dataset
NHD Plus	National Hydrography Dataset Plus
NID	National Inventory of Dams
NL	Natural Landscapes
NLCD	National Land Cover Dataset
NOC	BLM National Operations Center
NPMS	National Pipeline Mapping System
NRCS	Natural Resource Conservation Service
NREL	National Renewable Energy Laboratory
NRV	Natural Range of Variability
NTAD	National Transportation Atlas Database
NVDEP	Nevada Department Environmental Protection
NWI	National Wetland Inventory
ORV	Off-road Vehicle
PADUS	Protected Area Database of the U.S.
PCM	Parallel Climate Model
PEIS	Programmatic Environmental Impact Statement
PJ	Pinyon-Juniper
PL	Place
PLSS	public land survey system
POC	Point-of-Contact
PRISM	Parameter-elevation Regressions on Independent Slopes Model
QA/QC	quality assurance/quality control
QC	quality control
RAS	Rangeland Administration System
REA	rapid ecoregional assessment
REAWP	rapid ecoregional assessment work plan
ReGAP	Regional Gap Analysis Project
RegCM	International Centre for Theoretical Physics Regional Climate Model
RETI	Renewable Energy Transmission Initiative
RMP	resource management plan
ROC	Receiver Operating Characteristic
SAGEMAP	Sagebrush and Grassland Ecosystem Map Assessment Project

SAR	sodium adsorption ratio
SClass	succession class
SDM	Species Distribution Model
SERGoM	Spatially Explicit Regional Growth Model
SMA	Surface Management Agency
SO	State Office
SOW	statement of work
SSURGO	Soil Survey Geographic Database
STATSGO	State Soil Geographic Database
SUNY	State University of New York
SW ReGAP	Southwest Regional Gap Analysis Project
SWAP	State Wildlife Action Plan
SWEMP	Southwest Exotic Plant Mapping Program
T&E	threatened and endangered
TNC	The Nature Conservancy
TO	task order
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USGS-CD	USGS 15km dynamically downscaled climate model outputs
VDDT	Vegetation Dynamics Development Tool
WBD	Watershed Boundary Dataset
WGA	Western Governors' Association
WHB	Wild Horse and Burro

References

Bradley, B.A. 2009. Regional analysis of the impacts of climate change on cheatgrass invasion shows potential risk and opportunity. Global Change Biology 15: 196-208.

Comer, P.J. and J. Hak. 2009. NatureServe Landscape Condition Model. Technical documentation for NatureServe Vista decision support software engineering. NatureServe, Boulder CO.

Daly, C., W. P. Gibson, G.H. Taylor, G. L. Johnson, P. Pasteris. 2002. A knowledge-based approach to the statistical mapping of climate. Climate Research, 22: 99-113.

Flint, A.L., and Flint, L.E. 2007. Application of the basin characterization model to estimate in-place recharge and runoff potential in the Basin and Range carbonate-rock aquifer system, White Pine County, Nevada, and adjacent areas in Nevada and Utah. U.S. Geological Survey Scientific Investigations Report 2007-5099.

Gibson, W.P., C. Daly, T. Kittel, D. Nychka, C. Johns, N. Rosenbloom, A. McNab, and G. Taylor. 2002. Development of a 103-year high-resolution climate data set for the conterminous United States. In: Proc., 13th AMS Conf. on Applied Climatology, Amer. Meteorological Soc., Portland, OR, May 13-16, 181-183.

Intergovernmental Panel on Climate Change. 2007. IPCC Fourth Assessment Report (AR4). Cambridge University Press, Cambridge, UK. Available on-line: www.ipcc.ch/#.

Nachlinger, J., K. Sochi, P. Comer, G. Kittel, and D. Dorfman. 2001. Great Basin: an ecoregion-based conservation blueprint. The Nature Conservancy, Reno, Nevada, USA.

NatureServe. 2009. Terrestrial Ecological Systems of the Conterminous United States. Version 2.7. Completed in cooperation with USGS Gap Analysis Program and Inter-agency LANDFIRE. NatureServe, Arlington, VA, USA. Digital map.

Thomas, K.A. and P. Guertin. 2007. Southwest Exotic Mapping Program 2007: occurrence summary and maps of select invasive, non-native plants in Arizona. U.S. Geological Survey Open-File Report 2007-1277, 76 p. [http://pubs.usgs.gov/of/2007/1277/].

Appendix I

Central Basin and Range: Final Management Questions

MQ #	MQ Group	Preliminary MQ Proposed by BLM	Final Management Question	Reporting Unit	Reporting Metric
1	Species	What is the current distribution of occupied habitat for each CE, including seasonal habitat, and movement corridors?	What is the current distribution of potential habitat for each species CE?	Landscape Species & Species Assemblages: 30 m grid and 5th level HUC summary Local Species: Heritage 5th level HUC	Landscape Species & Species Assemblages: Areal Extent in acres Local Species: Number of Locations
2	Species	Where are species populations at risk?	Where are current locations of species CEs that are potentially affected by existing change agents (and thus potentially at risk)?	Landscape Species & Species Assemblages: 30 m grid and 5th level HUC summary Local Species: Heritage 5th level HUC	Landscape Species & Species Assemblages: Areal Extent in acres Local Species: Number of Locations
3	Species	What is the current distribution of suitable habitat for each CE?	What is the current distribution of suitable habitat, including seasonal habitat and movement corridors, for each landscape species and species assemblage CE?	Landscape Species & Species Assemblages: 30 m grid and 5th level HUC summary Local Species: Heritage 5th level HUC	Landscape Species & Species Assemblages: Areal Extent in acres Local Species: Number of Locations
4	Species	Where are change agents potentially affecting this habitat and/or movement corridors?	Where are existing change agents potentially affecting this current habitat and/or movement corridors, for landscape species and species assemblage CEs?	Landscape Species & Species Assemblages: 30 m grid and 5th level HUC summary Local Species: Heritage 5th level HUC	Landscape Species & Species Assemblages: Areal Extent in acres Local Species: Number of Locations

MQ #	MQ Group	Preliminary MQ Proposed by BLM	Final Management Question	Reporting Unit	Reporting Metric
5	Species	What/where is the potential for future change to this species?	Where are species CEs whose current locations or suitable habitats overlap with the potential future distribution of CAs (other than climate change)?	Landscape Species & Species Assemblages: 30 m grid and 5th level HUC summary Local Species: Heritage 5th level HUC	The same data sets from MQ 1 and 2 apply to answer these questions.
6	Species	What areas have been surveyed and what areas have not been surveyed (i.e., data gap locations)?	What is the relative survey intensity to date within the ecoregion for species CEs ?	ecoregion	High, Medium, Low survey effort
7	Species	Where are potential habitat restoration areas?	Given current and anticipated future locations of change agents, which habitat areas remain as opportunities for habitat enhancement/ restoration?	Landscape Species & Species Assemblages: 30 m grid and 5th level HUC summary Local Species: Heritage 5th level HUC	Location and Areal Extent in acres per 5th level HUC
8	Species	Where are potential areas to restore connectivity?	Where are potential areas to restore connectivity for landscape species and species assemblage CEs, based on current locations of change agents?	Landscape Species & Species Assemblages: 30 m grid and 5th level HUC summary Local Species: Heritage 5th level HUC	Landscape Species & Species Assemblages: Areal Extent in acres by habitat and species, total area by 5th level HUC
9	Species		Where will landscape species and species assemblage CEs experience climate outside their current climate envelope?	4th level HUC	Location and CE type with >1 standard deviations from baseline mean values for key climate variables relevant to each CE
10	Native Plant Communities	Where are intact CE vegetative communities located?	Where are intact CE vegetative communities located?	30 m grid and 5th level HUC summary	Areal Extent in acres per 5th level HUC
11	Native Plant Communities		Where are the likeliest current locations for high-integrity examples of each major terrestrial ecological system?	30 m grid and 5th level HUC summary	Areal Extent in acres per 5th level HUC
12	Native Plant Communities	What/where is the potential for future change to the community?	Where are existing and potential future CAs (aside from climate change) likeliest to affect current communities?	30 m grid and 5th level HUC summary	Areal Extent in acres per 5th level HUC

MQ #	MQ Group	Preliminary MQ Proposed by BLM	Final Management Question	Reporting Unit	Reporting Metric
13	Native Plant Communities		Where will current locations of these communities experience significant deviations from normal climate variation?	4th level HUC	Location and CE type with >2 standard deviations from baseline mean values for key climate variables relevant to each CE
14	Terrestrial Sites of High Biodiversity	Where are High Biodiversity sites?	Where are sites identified (but not necessarily designated) for High Biodiversity?	Polygon coverage and 5th level HUC summary	Areal Extent in acres per 5th level HUC
15	Terrestrial Sites of High Biodiversity	"Potential for future change" should be framed from the CA list	Where will CAs (aside from climate change) potentially affect sites of high biodiversity?	30 m grid and 5th level HUC summary	Areal Extent in acres + average landscape condition score; per 5th level HUC
16	Terrestrial Sites of High Biodiversity		Where will locations of these High Biodiversity sites experience significant deviations from normal climate variation?	4th level HUC	Location and CE type with >2 standard deviations from baseline mean values for selected climate variables
17	Aquatic Sites of High Biodiversity	What areas have been (and have not been) surveyed for spring snails and other species of concern?	What has been the general level of survey effort (ecoregion-wide, not site-specific) for spring snails and other species of concern?	ecoregion	Areal Extent in acres per 5th level HUC
18	Aquatic Sites of High Biodiversity	Where are Aquatic High Biodiversity sites?	Where are Aquatic High Biodiversity sites?	5th level HUC	Areal Extent in acres per 5th level HUC
19	Aquatic Sites of High Biodiversity	What/where is the potential for future change to these high-biodiversity sites?	Where will these Aquatic High Biodiversity sites be potentially affected by Change Agents (aside from climate change)?	5th level HUC	Areal Extent in acres per 5th level HUC
20	Aquatic Sites of High Biodiversity		Where will current locations of these Aquatic High Biodiversity sites experience significant deviations from normal climate variation?	5th level HUC	Areal Extent in acres per 5th level HUC
21	Specially Designated Areas of Ecological Value	Where are specially designated areas of ecological value?	Where are specially designated areas of ecological or cultural value?	Polygon coverage and 5th level HUC summary	Areal Extent in acres per 5th level HUC
23	Grazing, Wild Horses and Burros	Where are the current Herd Management Areas (HMAs)?	Where are the current Herd Management Areas (HMAs)?	source polygon map, optional presence by 5th level HUC	none, optional proportion of 5th level HUC
26	Grazing, Wild Horses and Burros		Where will CAs (excluding climate change) overlap HAs, HMAs, and GAs under each time scenario?	30 m grid and 5th level HUC summary	percent of each unit overlapped by CAs and summary percent of units overlapped by CAs by 5th level HUC

MQ #	MQ Group	Preliminary MQ Proposed by BLM	Final Management Question	Reporting Unit	Reporting Metric
27	Grazing, Wild Horses and Burros		Which HA's, HMA's and GA's will experience climate outside their current climate envelope?	4th level HUC & Management units of similar or larger size	Management units with >2 standard deviations from baseline mean values for selected climate variables
28	Soils	Where are these areas within the ecoregion?	Where are sensitive soil types within the ecoregion?	sensitive soil types in 30 m grid or source data format, 5th level HUC	percent of 5th level HUC area with sensitive soils
29	Soils	What/where is the potential for future change in conditions, such as due to climate change?	Where will target soil types overlap with CAs (aside from climate change) under each time scenario?	sensitive soil types in 30 m grid or source data format, 5th level HUC	percent of sensitive soil type overlapped by CAs, percent of 5th level HUC area with sensitive soils overlapped by CAs
29.5	Soils		Where will current sensitive soil types experience significant deviations from normal climate variation?	4th level HUC	Location and CE type with >2 standard deviations from baseline mean values for selected climate variables
30	Surface and Subsurface Water Availability	Where are these aquatic areas?	Where are current natural and man-made surface water resources?	5th level HUC	Areal Extent in acres per 5th level HUC
31	Surface and Subsurface Water Availability	What is the persistence of the flow (e.g., perennial, ephemeral) of these systems?	Of the current surface water resources (both natural and man-made), which are perennial, ephemeral, etc?	5th level HUC	Areal Extent in acres per 5th level HUC
82	Surface and Subsurface Water Availability		What is the natural variation of monthly discharge and monthly base flow for streams and rivers?	5th level HUC	Ecoregion wide, displayed by 5th level HUC
34	Surface and Subsurface Water Availability	Where are the aquifers and their recharge areas?	Where are the likely recharge areas within a HUC?	5th level HUC	Ecoregion wide
35	Surface and Subsurface Water Availability	What/where is the potential for future change in extent and flows from change agents?	Where will the aquifers (relating to aquatic CEs) identified in MQ 33 and the recharge areas (relating to aquatic CEs) identified in MQ 37 potentially be affected by Change Agents?	5th level HUC	Ecoregion wide, displayed by 5th level HUC
36	Aquatic Ecological Function and Structure	What is the condition of target aquatic systems? OR What is the condition of target aquatic systems in terms of PFC?	What is the condition (ecological integrity) of aquatic conservation elements?	5th level HUC	EIA scores

MQ #	MQ Group	Preliminary MQ Proposed by BLM	Final Management Question	Reporting Unit	Reporting Metric
39	Aquatic Ecological Function and Structure	Where are the degraded aquatic systems (e.g., water quality)?	Where are the aquatic CE occurrences with the most degraded condition (ecological integrity)?	5th level HUC	EIA Scores
40	Fire History	Where are the areas that have been changed from wildfire?	Where have fires greater than 1000 acres occurred?	polygons and extent by 5th level HUC	Areal extent, number of polygons and acres
42	Fire Potential	Where are the areas of potential future change from predicted wildfire? *(BLM amendment)*	What areas now have unprecedented fuels composition (invasive plants), and are therefore at high potential for fire?	30m Grid and extent by 5th level HUC	Areal extent in acres
43	Fire Potential	Where are the areas of potential future change from predicted wildfire? *(BLM amendment)*	Where are areas that in the future will have high potential for fire?	30m Grid and extent by 5th level HUC	Areal extent in acres
44	Invasive Species	Where are areas dominated by these invasive species?	What is the current distribution of invasive species included as CAs?	5th level HUC	Aquatic: # Taxa per 5th Level HUC/ Terrestrial Acres/percent of overall HUC area.
45	Invasive Species	Where are areas dominated by these invasive species?	What areas are significantly ecologically affected by invasive species?	5th level HUC	EIA Scores
46	Invasive Species	Where are areas with restoration potential?	Focusing on the distributions of terrestrial and aquatic CEs that are significantly affected by invasives, which areas have restoration potential?	5th level HUC	Terrestrial: EIA scores Aquatic: Aquatic Invasives Index Score
47	Invasive Species	Where are the areas of potential future encroachment from this invasive species?	Given current patterns of occurrence and expansion of the invasive species included as CAs, what is the potential future distribution of these invasive species?	5th level HUC	Terrestrial: Percent change in extent Aquatic: Aquatic Invasive Index: Surrounding HUC Metric
48	Development	Where are current locations of relevant development types?	Where are current locations of development CAs?	30m grid (except for source data at coarser resolution)	Area (in acres) of each development type by ecoregion and within 5th level HUC
49	Development	Where are areas of planned or potential development (outside of current urban areas) (e.g., under lease, plans of operation, governmental planning), including transmission corridors?	Where are areas of planned or potential development CAs?	30m grid (except for source data at coarser resolution)	Area (in acres) of each development type by ecoregion and within 5th level HUC
50	Development	Where are the areas of significant ecological change from these anthropogenic activities?	Where do development CAs cause significant loss of ecological integrity?	5th level HUC	Areas of low score from EI roll up

MQ #	MQ Group	Preliminary MQ Proposed by BLM	Final Management Question	Reporting Unit	Reporting Metric
51	Development		Where do current locations of CEs overlap with development CAs?	Each CE at 30 m or source resolution, optional roll up to 5th level HUC	Area of each CE overlapping development CEs, proportion of 5th level HUC with CA/CE overlap
52	Development		Where are ecological areas with significant recreational use?	30 m GRID or source data	Areal extent in acres
83	Oil, Gas, and Mining Development	Where are the current locations of Oil, Gas, and Mining (including gypsum) development?	Where are the current locations of oil, gas, and mineral extraction?	30 m GRID or source data	Area and percent of 5th level HUC occupied by these CAs
84	Oil, Gas, and Mining Development	Where are areas under plans of operation?	Where will locations of oil, gas, and mineral extraction potentially exist by 2025?	30 m GRID or source data	Area and percent of 5th level HUC occupied by these CAs
85	Oil, Gas, and Mining Development	Where are the areas of potential future locations of Oil, Gas, and Mining (including gypsum) development (locatable, salable, and fluid and solid leasable minerals?	Where are the areas of potential future locations of Oil, Gas, and Mining (including gypsum) development (locatable, salable, and fluid and solid leasable minerals)?	30 m GRID or source data	Area and percent of 5th level HUC occupied by these CAs
86	Oil, Gas, and Mining Development		Where do locations of current CEs overlap with areas of potential future locations of non-renewable energy development?	30 m GRID, 5th level HUC	Area and percent of 5th level HUC where CEs overlap these CAs.
87	Renewable Energy Development		Where are the current locations of renewable energy development (solar, wind, geothermal, transmission)?	30 m GRID, 5th level HUC	Area and percent of 5th level HUC where CEs overlap these CAs.
88	Renewable Energy Development	Where are the areas identified by NERL as potential and physically possible locations for renewable energy development?	Where are the areas identified by NREL as potential locations for renewable energy development?	30 m GRID, 5th level HUC	Area and percent of 5th level HUC where CEs overlap these CAs.
89	Renewable Energy Development		Where are the areas of low renewable and non-renewable energy development that could potentially mitigate impacts to CEs from potential energy development?	30 m GRID, 5th level HUC	Area and percent of 5th level HUC where CEs overlap these CAs.
90	Renewable Energy Development		Where do current locations of CEs overlap with areas of potential future locations of renewable energy development (MQ 65)?	30 m GRID, 5th level HUC	Area and percent of 5th level HUC where CEs overlap these CAs.

MQ #	MQ Group	Preliminary MQ Proposed by BLM	Final Management Question	Reporting Unit	Reporting Metric
81	Renewable Energy Development		Where will locations of renewable energy [development] potentially exist by 2025?		
54	Groundwater Extraction and Transportation	Where are the areas of potential future change from groundwater extraction?	Where will change agents potentially impact groundwater-dependent aquatic CEs?	5th level HUC	Ecoregion wide
56	Groundwater Extraction and Transportation		What is the present distribution of municipal and agricultural water use of groundwater resources in relation to the distribution of aquatic CEs?	5th level HUC	Ecoregion wide
57	Groundwater Extraction and Transportation	Where are the areas showing effects from existing groundwater extraction?	Where are the aquatic CEs showing degraded ecological integrity from existing groundwater extraction?	5th level HUC	Areal Extent in acres
58	Surface Water Consumption and Diversion	Where are artificial water bodies including evaporation ponds, etc.?	Where are artificial water bodies including evaporation ponds, etc.?	5th level HUC	Number of polygons
60	Surface Water Consumption and Diversion		Where are the areas of potential future change in surface water consumption and diversion?	5th level HUC	Areal Extent in acres based on 5th level HUCs
62	Surface Water Consumption and Diversion		Where are the CEs showing degraded ecological integrity from existing surface water diversion?	5th level HUC	EIA scores for surface water-related indicators for KEA 3, Surface Hydrology, specifically Indicator 3a, Flow Modification by Dams; and 3b, Surface Water Change – Upstream and within-System Augmentation / Diversion.
65	Climate Change: Terrestrial Resource Issues	Where are the areas of potential future change from climate change?	Where will changes in climate be greatest relative to normal climate variability?	4th level HUC	1 and 2 standard deviations from baseline mean values for key climate variables
66	Climate Change: Terrestrial Resource Issues	Where are the areas of potential for fragmentation?	Given anticipated climate shifts and the direction shifts in climate envelopes for CEs, where are potential areas of significant change in extent?	4th level HUC	Areal extent in acres by HUC indicating projected severe decreases vs. continued relative extent for each terrestrial CE being modeled.
67	Climate Change: Terrestrial Resource Issues	How will the distributions of native plant communities change with climate change?	Which native plant communities will experience climate completely outside their normal range?	4th level HUC	Location and CE type with >2 standard deviations from baseline mean values for key climate variables relevant to each CE

MQ #	MQ Group	Preliminary MQ Proposed by BLM	Final Management Question	Reporting Unit	Reporting Metric
68	Climate Change: Terrestrial Resource Issues	Where are the areas of potential of change of wildlife habitat?	Where will current wildlife habitats experience climate completely outside its normal range?	4th level HUC	Location and CE type with >2 standard deviations from baseline mean values for key climate variables relevant to each CE
69	Climate Change: Terrestrial Resource Issues		Where are wildlife species ranges (on the list of species CEs) that will experience significant deviations from normal climate variation?	4th level HUC	Location and CE type with >2 standard deviations from baseline mean values for key climate variables relevant to each CE
71	Climate Change: Aquatic Resource Issues	Where are the areas of potential future change from climate change?	Where will aquatic CEs experience significant deviations from historic climate variation that potentially could affect the hydrologic and temperature regimes of these aquatic CEs?	5th level HUC	Location and CE type with >2 standard deviations from baseline mean values for key climate variables related to watershed hydrology.
76	Military Constrained Areas	Where might these areas change in the future?	Where are areas of planned expansion of military use?	30m grid and/or source polygon	Area and percent of 5th level HUC occupied by these CAs
80	Atmospheric Deposition		Where are areas affected by atmospheric deposition of pollutants, as represented specifically by nitrogen deposition, acid deposition, and mercury deposition?	4th level HUC	EIA scores for surface water-related indicators for KEA 2, Surrounding Land Use Context, specifically Indicator 2e, Atmospheric Deposition

Appendix II

Conservation Elements for Assessment: Coarse-Filter CEs

This appendix summarizes coarse-filter CEs for the Central Basin and Range REA, including placement within ecoregional conceptual model, generalized land cover classification, and estimated current percentage.

Model Group	Land Cover Class	Conservation Element Name	Percent of Ecoregion
Montane Dry	Evergreen Forest and Woodland	Great Basin Pinyon-Juniper Woodland	13.8%
Montane Dry	Shrub-steppe	Inter-Mountain Basins Montane Sagebrush Steppe	3.9%
Montane Dry	Sparsely Vegetated	Inter-Mountain Basins Cliff and Canyon	0.7%
Montane Dry	Mixed Evergreen-Deciduous Forest and Woodland	Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland	0.6%
Montane Dry	Deciduous Forest and Woodland	Rocky Mountain Aspen Forest and Woodland	0.2%
Montane Dry	Evergreen Forest and Woodland	Inter-Mountain Basins Subalpine Limber-Bristlecone Pine Woodland	0.2%
Montane Dry	Mixed Evergreen-Deciduous Forest and Woodland	Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	0.0%
Montane Dry	Short Shrubland	Rocky Mountain Alpine Turf	0.0%
Basin Dry	Short Shrubland	Inter-Mountain Basins Mixed Salt Desert Scrub	20.0%
Basin Dry	Shrub-Steppe	Inter-Mountain Basins Big Sagebrush Shrubland	19.5%
Basin Dry	Short Shrubland	Great Basin Xeric Mixed Sagebrush Shrubland	9.6%
Basin Dry	Shrub-steppe	Inter-Mountain Basins Semi-Desert Shrub-Steppe	3.1%
Basin Dry	Short Shrubland	Mojave Mid-Elevation Mixed Desert Scrub	2.0%
Basin Dry	Upland Grassland and Herbaceous	Inter-Mountain Basins Semi-Desert Grassland	1.0%
Basin Dry	Shrub-steppe	Inter-Mountain Basins Big Sagebrush Steppe	0.3%
Basin Dry	Sparsely Vegetated	Inter-Mountain Basins Active and Stabilized Dune	0.2%
Basin Dry	Dwarf-shrubland	Colorado Plateau Mixed Low Sagebrush Shrubland	0.1%
Basin Dry	Tall Shrubland	Great Basin Semi-Desert Chaparral	0.0%
Montane Wet	Woody Wetlands and Riparian	Great Basin Foothill and Lower Montane Riparian Woodland and	1.1%

Model Group	Land Cover Class	Conservation Element Name	Percent of Ecoregion
		Shrubland/Stream	
Montane Wet	Woody Wetlands and Riparian	Rocky Mountain Lower Montane-Foothill Riparian Woodland and Shrubland/Stream	0.1%
Montane Wet	Woody Wetlands and Riparian	Rocky Mountain Subalpine-Montane Riparian Woodland/Stream	0.0%
Montane Wet	Woody Wetlands and Riparian	Rocky Mountain Subalpine-Montane Riparian Shrubland/Stream	0.0%
Montane Wet	Herbaceous Wetlands	Rocky Mountain Alpine-Montane Wet Meadow and Pond	0.0%
Basin Wet	Sparsely Vegetated	Inter-Mountain Basins Playa	5.7%
Basin Wet	Woody Wetlands and Riparian	Inter-Mountain Basins Greasewood Flat	5.1%
Basin Wet	Aquatic	Great Basin Lake/Reservoir	2.0%
Basin Wet	Herbaceous Wetlands	North American Arid West Emergent Marsh and Pond	0.2%
Basin Wet	Aquatic	Great Basin Springs and Seeps	0.0%
Basin Wet	Short Shrubland	Inter-Mountain Basins Wash	0.0%

Appendix III

Revised Aquatic CE Ecological Integrity Scorecard

Ecological Integrity Assessment Aquatic CE Indicators

The ecological integrity indicators for aquatic CEs have been updated from Memorandum 3, incorporating comments from the USGS and refinements in methods: the indicators Nutrient/ Pollutant Loading Index, Surface Water Runoff Index, and Sediment Loading Index have been combined into the Landscape Condition Model Index. The indicators Index of Hydrological Integrity, Stream Nutrient Condition: Nitrogen and Phosphorus Availability, and Native Fish Composition Index have been removed due to a lack of data and feasibility for the assessment. **Table 1. Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland /Stream CE Aquatic Ecological Integrity Indicators[1], with example score for hypothetical HUC**

Table 1 (below) contains the thresholds and sample scorecard values.

1. **Key Ecological Attribute: Extent / Size–** Changes in riparian corridor connectivity affect the flow of animals and nutrients with larger, longer corridors providing greater extent of habitat for wildlife and increased buffering capacity to the aquatic resource.
    a. Indicator: *Corridor Connectivity*—a measure of the degree to which the riparian area buffered to 200 m exhibits an uninterrupted (linear, un-fragmented) vegetated corridor.
2. **Key Ecological Attribute: Surrounding Land Use Context** —we measure several aspects of landscape condition related to land use that affect aquatic and wetland conditions:
    a. Indicator: Landscape Connectivity—the amount (% area) of natural landscape vs. developed area within the 5th Level HUC. This is a measure of connectivity from the animal movement perspective.
    b. Indicator: Landscape Condition Model Index-- a measure of the intensity of various land uses on ecosystem processes, including intensity of nutrient, pollutant, sediment and surface water runoff into aquatic CEs.
    c. Indicator: Atmospheric Deposition—a measure of the annual rate of deposition of a characteristic acidic/nutrient contaminant (Nitrogen) and a characteristic toxic contaminant (Mercury) based on data from the National Atmospheric Deposition Program. Atmospheric deposition introduces pollutants into watersheds and their aquatic ecological systems from distant sources. Deposition of nitrogen (N) and sulfur (S) can cause acidification in poorly chemically buffered waters such as exist in alpine and upper montane zones in the Central Basin and Range ecoregion and act as nutrient pollutants at lower elevations and in well-buffered waters. Deposition of toxic substances such as mercury (Hg) can lead to impairment of organism function and reproduction at higher levels in food webs that affect macroinvertebrate productivity.
    d. Indicator: Point-Source Pollution— a measure of the likely intensity of inputs from point sources of pollutants. The density of point-source discharges of chemical pollutants to water bodies in a watershed directly affects water quality within receiving waters unless permitted dischargers prevent all releases. Permitted and otherwise state-listed point sources in a watershed are identified using regulatory data and their density calculated per HUC-10 setting for each riparian-aquatic coarse-filter CE.
3. **Key Ecological Attribute: Surface Hydrology** — The surface hydrologic regime of stream ecosystems is often termed a "master variable" that shapes the biological conditions within the stream. Flow conditions – including their magnitude, timing, and duration – create a range of habitat opportunities, disturbances, and constraints that determine what organisms can persist within a stream ecosystem. These conditions also shape the geomorphology of the system which

in turn imposes its own opportunities and constraints on the biology and ecology of the system. The integrity of stream flow regimes is assessed conventionally using stream gage data, comparing current conditions to historic or modeled reference conditions. Unfortunately, stream gage data are very sparse within this ecoregion. Few streams across the ecoregion have gages and these gage records rarely provide the kinds of long-term records needed to assess change in environmental flows (and are mostly located only on the largest rivers). Therefore, the "best" indicator for this key ecological attribute – an Index of Hydrologic Integrity – cannot be implemented for purposes of this REA, which must provide information across the entire ecoregion rather than for a small number of spatially non-representative gage locations. We will instead assess this key ecological attribute using indicators of water resource infrastructure and water uses. Several of the indicators for Landscape Condition discussed above also provide information on the likely effects of human activities on HUC hydrology, specifically impacts on surface runoff. The three direct indicators of water use and one indicator of recharge zone surface integrity, below, provide additional, crucial information on the likelihood that hydrologic conditions are altered, and to what approximate extent.

a. Indicator: Flow Modification by Dams – a measure of the magnitude of dam infrastructure within a watershed using the "F" Index developed by Theobald et al. (2010) to assess the cumulative storage capacity of dams within a HUC relative to annual stream discharge from that HUC. The greater this cumulative capacity, the greater the potential of these dams to alter environmental flows.
b. Indicator: Surface Water Change – Upstream and within-System Augmentation / Diversion – a measure of the amount of surface water use upstream within a HUC based on published data on flow diversions, consumptive use, and augmentation (where applicable) as a percentage of the annual median discharge of the HUC. In the absence of gage data, the annual median discharge of each HUC will be estimated using NHD StreamStats data. Where these are not available or do not represent baseline (relatively unaltered) conditions, the analysis will use output data from the Flint and Flint (2007) Basin Characterization Model, scaled for comparability to StreamStats using adjacent HUCs.
c. Indicator: Ground Water Change: Augmentation/Withdrawal of Aquifers – a measure of the amount of groundwater use within a HUC that potentially could affect aquatic CEs based on published data on groundwater withdrawals and augmentation (i.e., artificial recharge, where applicable) as a percentage of the annual median surface discharge of the HUC. In the absence of gage data, the annual median discharge of each HUC will be estimated as described above for Indicator 3.b. Implementation of this indicator does not require assuming that groundwater withdrawals within a HUC affect aquifers that also support surface discharge (baseflow) from the same HUC. Rather, the annual median discharge of the HUC is used simply as a scaling value. We will also explore scaling the withdrawals relative to the total recharge volume for the HUC, as estimated by the Flint and Flint (2007) Basin Characterization Model.
d. Indicator: Ground Water Recharge Zone Integrity – a measure of the extent of hardened surfaces over recharge zones, which decrease infiltration to soil moisture and groundwater in these zones, thereby potentially influencing groundwater hydrology and stream flow characteristics. Recharge areas by Level 5 HUC will be mapped using data from Flint and Flint (2007). Land use intensity will be mapped using the Landscape Condition Index.

4. **Key Ecological Attribute: Water Quality**—This key ecological attribute focuses on direct evidence of water quality, and uses indirect evidence (based on the likely sources of impairment) only when no alternative is available. Unfortunately, aquatic systems within this ecoregion are not sampled often enough to provide an adequate database with which to develop consistent, spatially and temporally representative water chemistry data.

a. Indicator: State Impaired Waters — listings that categorize waters as impaired relative to their "designated uses" due to individual water quality properties. The state listings register the effects of degraded water quality due to altered turbidity, altered temperature, and a wide range of chemical contaminants. Some waters in the ecoregion contain naturally high levels of some minerals including salts of arsenic and other metals, as well as high levels of salinity in general. State standards do not apply to such naturally chemically rich waters.
b. Indicator: Buffer Sediment Loading Index —The type of land use within a 200 m buffer area to streams and springs, and a nationally standard index for that type of land use sediment index can be applied to each CE in the watershed. This is a surrogate measure for direct amount of suspended solid sediment. It is important to estimate both the surrounding landscape (see Key Ecological Attribute Surrounding Land Use Context: Sediment Loading Index) and the immediate buffer area to get a more accurate picture of impact on the aquatic resources, because the amount of natural vegetative cover within the buffer area can decrease the surrounding use impacts, or lack of natural cover can increase the impact.

5. **Key Ecological Attribute: Wetland Terrestrial Biotic Condition** — This key ecological attribute focuses on the integrity of native vegetation cover – a critical biological condition.
   a. Indicator: Cover of Exotic/Non-native Invasive Plant Species — a measure of the impacts of non-native plant species on native plant cover. This indicator measures the presence and abundance of aggressive non-native plant species known to invade wetlands, especially those associated with human disturbance. Species such as *Tamarix* and cheat grass may drive out native species, altering habitat invertebrate composition and food trophic levels of riparian ecosystems.
6. **Key Ecological Attribute: Aquatic Biotic Condition** — This key ecological attribute focuses on the integrity of the faunal community within the water – a critical biological condition.
   a. Indicator: Benthic Macroinvertebrate Assemblage Composition Index — Benthic macroinvertebrate assemblages in desert streams are naturally variable. However, systematic surveys are feasible and routinely used by state and federal agencies responsible for regulating water quality and stream condition. These surveys can produce consistent results that support comparisons if focused on specific habitats (e.g., riffles) and sampled during a consistent hydrologic season (e.g., early summer low-flow season) during consistent flow conditions (e.g., baseflow) using standard field methods followed with standard lab and statistical methods. Standard data available are: 1) multi-indicator indices of assemblage biotic integrity, or 2) a multivariate methodology to establish statistical expectations for reference conditions against which individual samples are compared. Both approaches produce an overall score that places samples along a continuum from least- (reference-quality) to most-altered. Benthic macroinvertebrate assemblage monitoring in western streams is commonly carried out as a component of stream water quality assessment for regulatory purposes, often through systematic state-wide or ecoregion-wide sampling programs.
   b. Indicator: Aquatic Invasive Species Impact Index – a measure of the likely impact of aquatic invasive species on stream biotic integrity. The aquatic invasive species (taxon) impact index includes indicators that focus on the most important ecological and landscape factors identified in invasive species life history from ecological and invasion theory. . Indicators in this model are separated into two major categories: 1) Within HUC and 2) Surrounding HUCs. The Aquatic Invasive Species Index has been simplified and improved in order to stream line the GIS process and to better answer MQs. For the Within HUC index, we condensed three metrics into one using the Landscape Condition Model Index for level of human activity rather than road density, recreational use and urbanization. The Surround HUC index has been modified more significantly. First we will keep this metric as a separate

"Future Potential Invasive Index" for two time frames: the 2025 and 2050 scenarios. Second, we reduced the number of indicators from 13 metrics to just 3 (number of novel invasive taxa, number of surrounding infected HUCS, and the degree of human use). We eliminated the "invasiveness ecology" indicator (3 metrics) that ranked each invasive species as our research shows that all 12 invasive species used in this assessment score equally highly invasive. The "proximity to infection and connectivity" (4 metrics) – was boiled down to a single measure of the number of immediate adjacent infected HUCs for the 2025 scenario and the number of infected HUCs at a greater distance (still to be determined) for the 2050 scenario. Four metrics for human activity are replaced by the Landscape Condition Model Index. And finally we eliminated the "time since first invasion" because this metric is used in the within HUC metric. For full tables of individual indicator scores, see Aquatic Invasive Index Appendix.

Table 1. Great Basin Foothill and Lower Montane Riparian Woodland and Shrubland /Stream CE Aquatic Ecological Integrity Indicators[1], with example score for hypothetical HUC

Key Ecological Attribute and Indicator(s) n=20		Definition and Measurement	Sustainable	Transitioning	Degraded	Score
Used in CBR REA		**Index Value (unless otherwise stated)**	0.9	0.6	0.25	
Extent / Size (1 indicator)						
Yes	**Riparian Corridor Continuity**	Indicates the degree to which the riparian areas (buffered by 200 m) exhibit an uninterrupted corridor. A measure of the linear, continuous unfragmented riparian corridor based on Landscape Condition Index (LCI), to measure how many fragments are created by the interruption of the natural riparian corridor by non-natural land use.	>20% of riparian reach with gaps/breaks due to cultural alteration	>20-50% of riparian reach with gaps/breaks due to cultural alteration	>50% of riparian reach with gaps/breaks due to cultural alteration	**.6**
Surrounding Land Use Context (4 indicators)						
Yes	**Landscape Connectivity** (Surrounding HUC 8 Digit)	A measure of the percent of unaltered (natural) habitat within a 1,000 ha (10km^2) or surrounding HUC (8 digit) based on LCI	Intact to Variegated: Embedded in 60-100% natural habitat; habitat connectivity is generally high, but lower for species sensitive to habitat modification.	Fragmented: Embedded in 10-60% natural habitat; connectivity is generally low, but varies with mobility of species and arrangement on landscape.	Relictual: Embedded in < 10% natural habitat; connectivity is essentially absent.	**.6**
Yes	**Landscape Condition Model Index**	Land use impacts vary in their intensity, affecting ecological dynamics that support ecological systems. This will include indices for Nutrient Loading, Sediment loading, and Surface water runoff	Cumulative level of impacts is sustainable. Landscape Condition Model Index is > 0.8	Cumulative level of impacts is transitioning system between a sustainable and degraded state. Landscape Condition Model Index is 0.8 – 0.5	Cumulative level of impacts has degraded system. Landscape Condition Model Index is< 0.5	**.8**

Key Ecological Attribute and Indicator(s) n=20		Definition and Measurement	Sustainable	Transitioning	Degraded	Score
Yes	**Atmospheric Deposition**	Rate of deposition of NO_x and Hg per unit area within HUC.	TBA	TBA	TBA	
Yes	**Point-Source Pollution** (known mapped points)	Density of permitted and legacy point discharges within HUC10. From states permit db	None	1-2	>2	**.9**
Hydrology Condition (4 Indicators)						
Yes	**Flow Modification by Dams**	"F" Index (Theobald et al. 2010)-- Dams and their storage capacity relative to annual stream discharge	F index >0.90	F index = 0.75-0.90	F Index <0.75	**.9**
Yes	**Surface Water Change: Upstream and within-System Augmentation / Diversion**	Average annual surface water diversions and augmentation expressed as a percent of baseline annual median surface discharge for a HUC. Baseline surface discharge values from StreamStats or estimated using Flint and Flint (2007) or other data where StreamStats not given.	Percent added/removed is <10% of average annual natural median flow	Percent added/removed is 10-25% of average annual natural median flow	Percent added/removed is >25% of average annual natural median flow	**.9**
Yes	**Ground Water Change: Augmentation/ Withdrawal of Aquifers**	Average annual groundwater withdrawals and augmentation expressed as a percent of annual baseline median surface discharge for a HUC. Baseline surface discharge values from StreamStats or estimated using Flint and Flint (2007) or other data where StreamStats not given.	Percent added/withdrawn is <10% of average annual natural median flow	Percent added/withdrawn is 10-25% of average annual natural median flow	Percent added/withdrawn is >25% of average annual natural median flow	**.6**
Yes	**Groundwater Recharge**	Measures the integrity of the groundwater recharge zone (Level 5 HUC) by percent area in natural land cover as determined in LCI.	Average percent >67% across all recharge areas within HUC identified in Flint & Flint (2007) study.	Average percent 34-66% across all recharge areas within HUC identified in Flint & Flint (2007) study.	Average percent <34% across all recharge areas within HUC identified in Flint & Flint (2007) study.	**.9**
Water Quality Condition (2 indicators)						
Yes	**Stream Other Water Quality Conditions: State-Listed Water Quality Impairment**	Measures the integrity of water quality conditions in individual water bodies based on the presence and severity of state listings of water quality impairments for State 303(d) reporting requirements under the federal Clean Water Act – excluding nutrient enrichment, which is addressed by a separate key ecological attribute.	Natural or Native reference conditions or Minimal changes in the structure of the biotic community and minimal changes in ecosystem function	Evident to moderate changes in structure of the biotic community and minimal to moderate changes in ecosystem function	Major to severe changes in structure of the biotic community and moderate changes to major loss in ecosystem function	**.9**

Key Ecological Attribute and Indicator(s) n=20		Definition and Measurement	Sustainable	Transitioning	Degraded	Score
Yes	**Sediment Loading Index** (From immediate buffer area 200 m)	Cumulative Sediment Loading by Index Coefficients measured by percent different land uses contribute excess sedimentation and suspended solids via surface water runoff and overland flow into a wetland, as measured by LCI	Sediment Loading Index = 0.8 – 1.0	Sediment Loading Index = 0.51– 0.79	Sediment Loading Index <0.5	**.6**
Wetland Terrestrial Biota Condition (1 Indicator)						
Yes	**Cover of Exotic/Non-native <u>Invasive</u> Plant Species**	Not all non-native species are aggressive. These indicators measure the presence and estimate the abundance of aggressive non-native plant species known to invade wetlands, especially those with human disturbance.	Exotic invasive plant species absent or, if present no more than 1-2% cover.	Exotic invasive plant species prevalent (3–10% cover).	Exotic invasive plant species abundant (>10% cover).	**.25**
Aquatic Biota Condition (2 Indicators)						
Yes	**Benthic Macro-invertebrate Assemblage Composition Index**	Measures the integrity of the benthic macroinvertebrate assemblage based on a multivariate "O/E" methodology or a multi-indicator index of biological integrity (IBI) and state aquatic life use standards	Natural or Native reference conditions or Minimal changes in the structure of the biotic community and minimal changes in ecosystem function	Evident to moderate changes in structure of the biotic community and minimal to moderate changes in ecosystem function	Major to severe changes in structure of the biotic community and moderate changes to major loss in ecosystem function	**.6**
Yes	**Invasive Aquatic Index**	A sum of the within HUC and surrounding HUC Aquatic Invasive Index for Stream CE.	See Aquatic Invasive Index (see Appendix IV)	See example scoring for HUC and Surrounding HUC (Appendix IV)		**.25**
Landform Condition (1 indicator)						
Yes	**Lateral Floodplain Hydrologic Connectivity**	Riparian zone/Valley Confinement Index (Theobald 2010). This measures what land uses occur within the floodplain that separate the stream channel from its adjacent floodplain.	Completely connected to floodplain; no geomorphic modifications made to contemporary floodplain. OR Minimally disconnected from floodplain; up to 25% of streambanks are affected.	Moderately disconnected from floodplain due to multiple geomorphic modifications; 25 – 75% of streambanks are affected.	Extensively disconnected from floodplain; > 75% of streambanks are affected.	**.6**
∑ sum of 15 indicator scores = 9.4 Divided by 15 = 0.62 **Transitioning**						**0.62**

[1]The indicators Nutrient/ Pollutant Loading Index, Surface Water Runoff Index, and Sediment Loading Index have been combined into the Landscape Condition Model Index. The indicators Index of

Hydrological Integrity, Stream Nutrient Condition: Nitrogen and Phosphorus Availability, and Native Fish Composition Index have been removed due to a lack of data and feasibility for the assessment.

Appendix IV

Revised Aquatic Invasive Species Index

The Aquatic Invasive Species Index originally proposed in Memorandum 3c has been simplified and improved to streamline the spatial analysis and to better answer MQs. Both the Within HUC and Surrounding HUC indices have been modified. We condensed three Landscape Context metrics (road density, recreational use, and urbanization) into the Landscape Condition Model Index metric for level of human activity in the Within HUC index. We also slightly modified several other metrics in the Within HUC index.

The Surrounding HUC index has been modified significantly more than the Within HUC index. We changed the Surrounding HUC index to the Potential Future Invasive Index; this index will be calculated for two time frames: 2025 and 2050. We reduced the number of metrics from thirteen metrics to three metrics: number of novel invasive taxa, number of surrounding infected HUCS, and degree of human use. We eliminated the three "invasiveness ecology" metrics because all of the invasive species in this assessment score as "highly" invasive. The four "Proximity to infection and connectivity" metrics were condensed to a single measure of the number of immediate adjacent infected HUCs for the 2025 scenario and the number of infected HUCs at a greater distance for the 2050 scenario. The distance measure for the 2050 scenario is still to be determined. Four metrics for human activity have been replaced by the Landscape Condition Model Index. We also eliminated the "time since first invasion" because this metric is used in the Within HUC index and other metrics implicitly incorporate time.

Table 1. Within HUC Aquatic Invasive Species Impact Index

Within HUC Index					
Level	**Metric category**	**Metric**	**Justification**	**Data Source**	**Evaluation and score**
Biotic	**Number of invasives**	1. Number of invasive taxa present in CE	The greater the number of invasive taxa there are in a CE, the greater the impairment	USGS NAS, USGS didymo database, Natural Heritage Programs attributed to specific CEs (~90% of the records)	0 taxa = 3 1 taxon = 2 > 1 taxon = 1
		2. Number of probable invasives in CE	See metric 1	Records in datasets that lack specific CE attributes (~ 10% of data). Based on CE invasive potential (Table 3)	Weight less than #1
	Number of CEs infected/ mean HUC size[2]	3. Number of CE's infected	The greater the number of CEs infected, the greater the impairment	USGS NAS, USGS didymo database, Natural Heritage Programs	Number of CEs infected 0 = 3 1-2 = 2 > 3 = 1

Within HUC Index					
Level	**Metric category**	**Metric**	**Justification**	**Data Source**	**Evaluation and score**
	Trophic levels	4. Number of trophic levels	Number of trophic levels equates to decreased integrity (through interspecific competition and greater potential changes in predation & primary production)	Ecological literature & Table 3	None = 3 1 trophic level = 2 >1 trophic level = 1
		5. Number of probable infected trophic levels in CE	See metric 4	Based on data from Metric #2 and Table 3	Weighted less than # 4
Abiotic	**Connectivity**	6. Flow network connectivity	Connected water bodies are more likely to become infected	Inverse of Riparian Corridor Continuity Measurement	Inverse of Riparian Corridor Continuity Measurement Score
		7. Upstream or downstream from infected site	Most invasive taxa are better able to disperse downstream (drift) than upstream	Possibly available from NHD locator codes	Upstream = 2 Downstream = 1
Landscape context	**Use**	8.Landscape Condition Model Index	Increased human activity strongly correlates with increased infection rates to other CEs	Landscape Condition Model Index (LCMI) for HUC	Based on LCMI Scores
Time	**Time since invasion**	9. Time since first invasion (reported date)	The longer an invasive taxa has been in a CE, the more impact it has had [2]	USGS NAS, USGS didymo database, Natural Heritage Programs	Absent or newly arrived (≤ 5 yrs) = 3 Moderate history (> 5 ≤ 20 yrs) = 2 Long history (> 20 yrs) = 1

[1]See Table 3 for list of potential CEs an invasive taxon may infect. Also, if they are known to occur in ecologically similar habitats to the CE within the HUC, they may already be present in the CE.

[2]Elton (1958) suggested that often the full ecological impacts of an invasive species are not realized until 50 to 100 years after introduction.

Table 2. Potential Future Aquatic Invasive Index

This index will be calculated for two time frames: short (2025) and long term (2050).

Potential Future Aquatic Invasive Index					
Level	**Metric category**	**Metric**	**Justification**	**Data Source**	**Evaluation and score**
Biotic	**Number of invasives**	1 Number of novel[1] invasive taxa present at the HUC 8 level	More invasives nearby equals greater potential impact	USGS NAS, USGS didymo database, Natural Heritage Programs	HUC 8 level: 0 = 3 1 = 2 > 1 = 1
Distance	**Proximity to infection and connectivity**	2. Number of infected HUCs with novel taxa immediately adjacent (short term- 2025 scenario) and within larger area (for long term- 2050 scenario)[2]	Nearby infected HUCs are more likely to spread to uninfected HUC (e.g. propagule pressure). Invasive species spread by many methods.	USGS NAS, USGS didymo database, Natural Heritage Programs	0 = 3 1 = 2 >1 = 1
Landscape context	**Use**	3. Amount of human activity	Increased human activity strongly correlates with increased infection rates	Landscape Condition Model Index CE/HUC	None = 3 Limited = 2 > Limited = 1

[1] Novel invasive taxa are not reported in the CE being evaluated within a HUC but occur in adjacent HUCs.

[2] Larger area to be determined.

Table 3. Trophic level or functional feeding group and CE invasive potential
CE invasive potential is the types of CEs that an invasive taxon is likely to infect.

Taxon	Trophic level/ functional feeding group	CE invasive potential
Diatoms		
Didymo, rock snot *Didymosphenia gemenata*	Primary producer	1, 2, 3, 4, 5, 6, 7, 8, 11, 12, 15, 16
Macrophytes		
Curlyleaf pondweed	Primary producer	3, 5, 6, 7, 8, 11, 14, 15, 16
Eurasian watermilfoil	Primary producer	3, 5, 6, 7, 8, 11, 14, 15, 16
Gastropods (snails)		
Applesnails *Pomacea* sp.	Grazer/scraper	3, 5, 6, 7, 11, 14, 15, 16
European ear snail *Radix auricularia*	Grazer/scraper	3, 5, 6, 7, 11, 14, 15, 16
Red-rim melania *Melanoides tuberculatus*	Grazer/scraper	3, 5, 6, 7, 11, 14, 15, 16
New Zealand mudsnail *Potamopyrgus antipodarum*	Grazer/scraper	1, 2, 3, 4, 5, 7, 8, 11, 12, 15, 16
Chinese mystery snail *Cipangopaludina chinensis malleata*	Grazer/scraper	3, 5, 6, 7, 11, 14, 15, 16
Bivalves (clams/mussels)		
Asian clam *Corbicula fluminea*	Filterer	5, 11
Zebra and Quagga mussels *Dreissena* sp.	Filterer	1, 2, 3(?), 4(?), 5, 6(?), 7(?), 8, 11, 12, 15(?), 16(?)[a]
Amphibians		
African clawed frog *Xenopus laevis*	Adult = Predator Larvae = filterer/grazer	1,2, 3,4, 5, 6, 7, 8, 10 (?), 11, 12, 14, 15, 16
American bullfrog *Lithobates* (=*Ranus*) *catesbeianus*	Adult = predator Larvae = grazer	1, 2 ,3, 4 , 5, 6, 7, 8, 11, 12, 14, 15, 16
Fish		
Mollies and guppies *Poecilia* sp.	Predators	1, 5, 6, 7, 8, 11, 12, 14, 15, 16
Tilapia *Oreochromis* sp	Omnivore; plankton/macrophytes	1, 5, 6, 7, 8, 11, 12, 14, 15, 16
Asian/European carp Family Cyprinidae	Grazer/Predator/Molluscivore/Omnivore	1, 5, 6, , 8, 11, 12, 14

[a]Zebra and Quagga mussels have only recently invaded western USA waters. Thus, the types of water bodies (CEs) that they can invade in the western USA are unknown.

Elton, C.S. 1958. The ecology of invasions by plants and animals. London: Methuen and Co.